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The Late Miocene Mammal Faunas of the Mytilinii Basin, Samos Island, Greece: New Collection

2. Lithostratigraphy and Fossiliferous Sites

by

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Abstract

This study modifies previous lithostratigraphic subdivisions and updates the ages of the Neogene deposits in the Mytilinii Basin, Samos, Greece. Five successive formations are recognized: the Basal Fm, the Mavradzei Fm, the Hora Fm, the Mytilinii Fm and the Kokkarion Fm. Analogies of the lower units with those in the horst and graben complex of western Turkey suggest that Mytilinii basin was originally part of an extensive lacustrine system activated during Early-Middle Miocene in western Anatolia. The correlation of new vertebrate fossil sites in the Mytilinii Fm with the presiously known fossil quarries and the local stratigraphy are discussed.

Keywords: Late Miocene, Samos, Greece, Lithostratigraphy, Fossil-Sites.

Zusammenfassung

Diese Studie modifiziert die bisherigen lithostratigraphischen Untereinheiten und bringt die neogenen Ablagerungen des Mytilinii Beckens auf den neusten Stand. Fünf aufeinander folgende Formationen werden unterschieden: die Basal, die Mavradzei-, die Hora-, die Mytilinii- und die Kokkarion Formation. Analogien der unteren Einheiten mit jenen aus dem Horst- und Grabenkomplex aus der Westtürkei legt nahe, dass das Mytiliniibecken einst ein Teil eines ausgedehenten lacustrinen Systems war, welches im frühen bis mittleren Miozän in Westanatolien seine Anfang nahm. Diskutiert wird die Korrelation der neuen Wirbeltierfundstellen aus der Mytilinii-Formation im Vergleich mit den schon bekannten Aufschlüssen, sowie die lokale Stratigraphie.

Schlüsselworte: Obermiozän, Samos, Griechenland, Lithostratigrapie, Fossilfundstellen.

1. Introduction

Samos Island is situated in the Aegean Sea, near the seashores of Asia Minor (Fig. 1) and is well known amongst geoscientists because of its rich fossil-bearing Neogene deposits. Historical data about the island and its fossils are given by Koufos (this volume). The position of Samos in the geotectonic system of the SE Balkans is not yet clearly understood since the relations between the Atticocycladic Zone in Greece and the Menderes Massif in Asia Minor have not been clarified. Samos is considered to be either part of the Atticocycladic Zone (Alther et al., 1982; Mposonkay, 1995) or of the western limits of the Menderes Massif (Papanikolaou, 1979). In a more recent review, Ring et al. (1999) and Gessner (2000) mentioned major differences between these two units and suggested that only the upper parts of the Anatolian belt can be correlated with the Atticocylcadic Zone; hence the Menderes nappes have no counterpart in the adjacent Aegean region.
The pre-Neogene basement of Samos consists of a continuous series of metamorphic rocks and an allochthonous unit of non-metamorphic rocks of Middle Triassic - Late Jurassic age (Theodoropoulos, 1979). Five tectonic units have been recognized (Papanikolaou, 1979):

- The **Kerketeas Unit**, consists of a thick series of marbles (~1000 m), followed by a thin series of yellowish phyllites (~50 m).
- The **St. John Unit** is a tectonic slice between the Kerketeas and Ambelos units, consisting of basic metavolcanic rocks.
- The **Ambelos Unit** is comprised of alternated marbles, sipolines and mica-schists.

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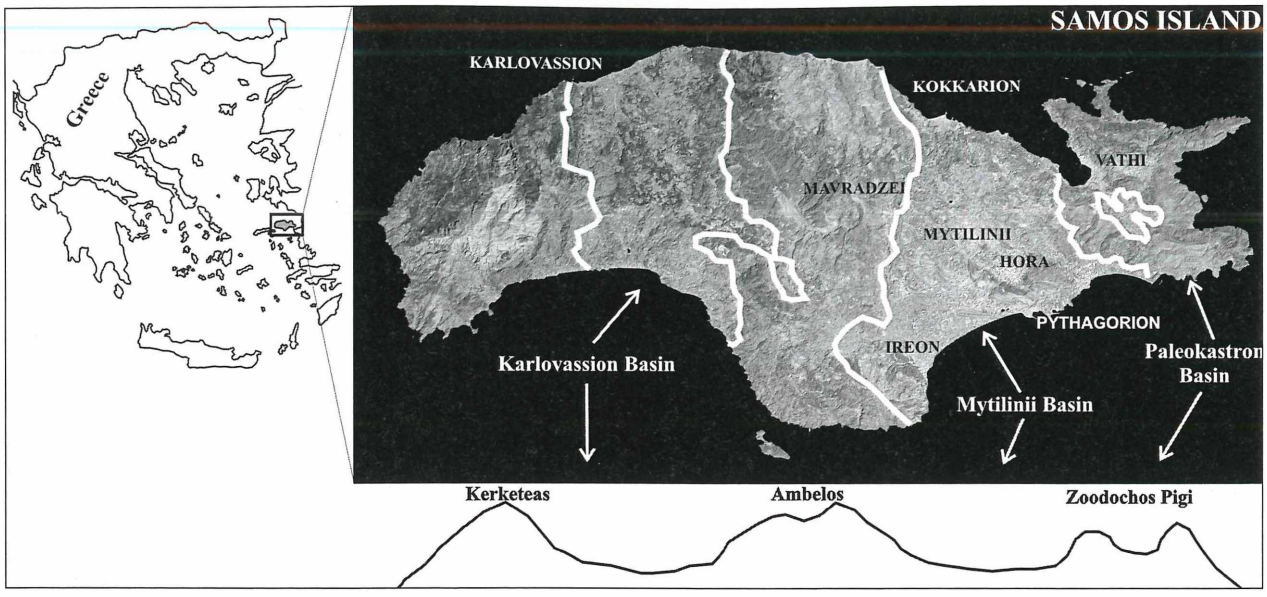

Figure 1: Sketch map of Greece showing the position of Samos Island in the Aegean Sea and aero-map of the island indicating the main villages and the Neogene basins.

• The **Vourliotes Unit** is made up by marbles and mica-schists that tectonically overly the Ambelos Unit.
• The **Kallithea Unit** overlies the previous metamorphic units and consists of Middle-Late Triassic basic volcanic rocks (~400 m), followed by Late Triassic-Jurassic massive limestones or oolitic limestones (~100-150 m).

The metamorphic mountainous part of Samos is interrupted by two main Neogene depressions, the Karlovassion Basin and the Mytilinii Basin (Fig. 1), which are connected by a narrow passage known as the Pyrgos Basin; the secondary Paleokastron Basin is developed in the eastern part of the island (Mountrakis et al., 2003). The Samos basins seem to take part of the broad Western Anatolia complex of horst and graben system. The Karlovassion and Mytilinii basins are situated at the crossing of the southern prolongation of the N-S trending Çubukludağ graben, between Izmir and Karaburun Peninsula and the western prolongation of the E-W trending Büyük Menderes graben (Turkey). The Samos basins are filled in by Neogene deposits, while Quaternary sediments are relatively thin and restricted to the flat areas.

2. Stratigraphy of the Mytilinii Basin

The study of the Neogene deposits exposed in the Mytilinii Basin has always been enhanced by their richness in fossil mammals. The famous fossiliferous Late Miocene localities of Samos are located in the north-western part of the NNW-SSE trending Mytilinii Basin, which is bounded by the mountain chains of Ambelos and Zoodochos Pigi (Fig. 1). In this chapter we give all the available stratigraphic information for the Mytilinii Basin, combining bibliographic references with our field observations. On the basis of this data the composite stratigraphic column that will be used in the following chapters of this volume has been reconstructed. The Neogene deposits of the Mytilinii Basin were already mentioned by geologists in the nineteeth century (Spratt, 1847; Nasse, 1875; Guerin, 1856; Stefani et al., 1892) but thorough and detailed works were published later by Angélier (1976), Meissner (1976), Theodoropoulos (1979), Solounias (1981), Weidmann et al. (1984) and Tsombachidou (1999). Table-1 summarizes the stratigraphic studies of the Neogene deposits in the Mytilinii Basin. The more recent studies are in good agreement, except for some differences in the lower stratigraphic horizons. This part of the section is referred to as the Lower Limestone (Spratt, 1846; van Couvering & Miller, 1971), the Avlakia Formation (Angélier, 1976) or the Lower series (Theodoropoulos, 1979). In the best known lithostratigraphic subdivision of the Mytilinii Basin by Weidmann et al. (1984), this part of the section is subdivided into three formations in a similar way as proposed earlier by Meissner (1976).

The **Basal Formation** (Tab. 1) overlies the pre-Neogene basement unconformably. The formation can be traced in the western part of the basin only, across the "Mavradzei Fault" and north of the Mavradzei village, where its thickness reaches 40 m (Figs 2, 3). It consists of red-brownish sands alternating with gravel lenses and lenticular intercalations of conglomerates and sandstones, deposited in alluvial fan conditions. The gravels and pebbles originate from the basement and decrease in size upwards, where the sands predominate and palaeosols occur, suggesting flood plain depositional environment. The dip of the lower beds follows the relief of the basement, ranging between 40°-50° but the inclination of the beds decreases towards the top of the formation.

Weidmann et al. (1984) include the bituminous freshwater limestones with intercalations of lignitic clays (Mavradzei beds) that conformably overlie the basal conglomerate in the region of Mavradzei village, as well as, the thick-bedded limestones exposed in Spiliani Hill,

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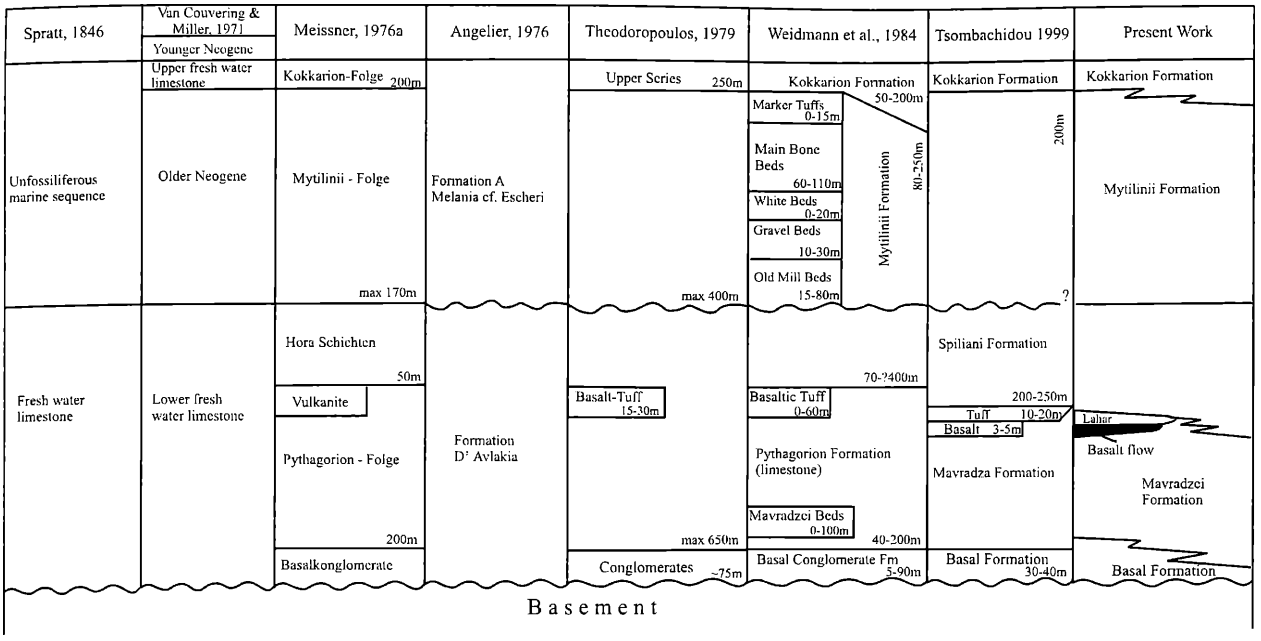

Table 1: Stratigraphic comparison of previous studies complied in the Mytilinii Basin, Samos, Greece.

northeast of Pythagorion village, into their Pythagorion Fm (Tab. 1). Several problems arise from this interpretation. The limestones of the Mavradzei beds are quite different from those exposed in Spiliani Hill, containing a rich gastropod fauna and intercalations of organic clays. In contrast, the Spilliani limestones are white and rather massive with cavities and cracks filled with crystallized calcite. Furthermore, a fault separates the stratotype Kavos Fonias section of Pythagorion Fm (WEIDMANN et al., 1984) from Spiliani Hill, obscuring stratigraphic continuity, whereas the Mavradzei beds are not observable at the base of Spiliani Hill, presumably due to colluvium slope cover.

Fresh artificial sections along the shoreline between Pythagorion village and Kavos Fonias show that a part of the lower limestones of the type section has a more travertinous aspect and includes clastic sediments with tuffaceous material and casts of *Phragmites* stems and turriform gastropods resembling *Brotia* sp.; all these features oppose their inclusion into the same unit with Spiliani Hill's limestone and indicate that at least part of the Kavos Fonias type section may belong to the younger Kokkarion Fm.

Similar problems do also occur with the upper boundary of Pythagorion Fm. WEIDMANN et al. (1984) correlate a tuffaceous green-yellowish clay bed about 2 m thick, outcropping northern of Hora village (Fig. 4) with the basalt flow and associating lahar exposed in the western margin of the basin, north of Mavradzei village (Figs 2, 3) and suggest this bed as the border between the Pythagorion Fm and the succeeding Hora Fm (Tab. 1). Nonetheless, the volcanoclastic sequence of Mavradzei is wedging out eastwards and probably disappears, whereas the particular tuffaceous clay bed cannot be traced in the wider Hora region. Still, several tuffaceous clay beds of variable thickness have been found in the fresh-water limestones outcropping between Hora and Mytilinii villages. All the above mentioned observations indicate that Pythagorion Fm as proposed by WEIDMANN et al. (1984) cannot stand up as a distinct and well-defined lithostratigraphic unit and therefore an alternative interpretation is given:

The forty meters thick series of white-grey bituminous fresh-water limestones with alternation of green-yellowish clays and mudstones and intercalations of lignitic lenses that overlies the basal conglomerates conformably and rather gradually is referred to as **Mavradzei Fm.** (Figs 2, 3, Table 1). The limestones and mudstones include a rich fauna of lacustrine gastropods mainly *Planorbis*, *Lymnaea*, *Bithynia* and Hydrobiidae indet. (Fig. 5a), which are extensively broken and deformed. The pollen association collected from the lignitic horizons is studied elsewhere (IOAKIM & KOUFOS, this volume). The depositional environment corresponds to distal alluvial-fan facies with vegetated swampy and marshy areas passing laterally into marginal lacustrine conditions. A two meters thick basalt flow and the overlying 20 m beige-green volcanoclastic deposit of lahar-type with white-grey pebbles of volcanic origin complete the formation. This volcanic sequence is correlated to the Middle-Late Miocene volcanic activity of the SE Aegean region (FYTIKAS et al., 1984). Taking into account that radiometric datings indicate an age of 11.2±0.7 My for the basalt flow and 10.8±0.4 My for the lahar (WEIDMANN et al., 1984), a Middle Miocene (Astaracian) age is suggested for the Mavradzei Fm. Although the Basal and Mavradzei Fms have a limited occurrence in the Mytilinii basin, similar lithostratigraphic units of about the same age and with much wider stratigraphic development occur at the same time in several western Anatolian basins (GÜRER et al., 2001; GENÇ et al., 2001; YAĞMURLU et al., 2004; ALÇIÇEK et al., 2007), suggesting an analogous depositional environment in a broader area. This environment corresponds to the beginning of an

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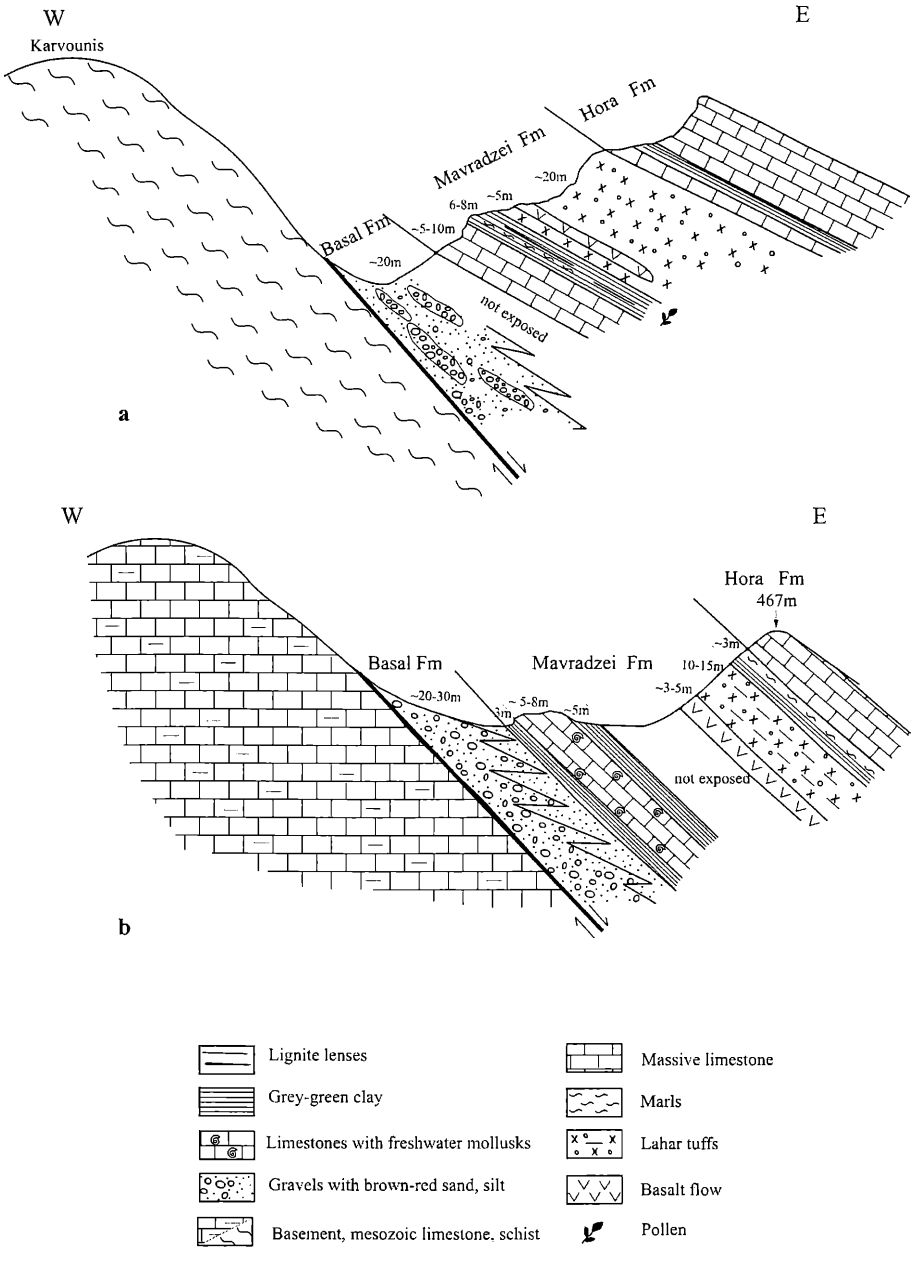

Figure 2: Field sketches of the lower Neogene deposits of Mytilinii basin, Samos in contact with the pre-Neogene bedrock. a. "Kazania" district; b. "Rema Kavouraki" district.

extensive lacustrine system, whose emergence should be dated back to the Early-early Middle Miocene; in the equivalent Söke Fm of the neighboring Söke/Kuşadaşi basin and the Kizilburun Fm of the Denizli basin (Asia Minor) micromammalian faunas of Orleanian age have been found (Gürer et al., 2001; Alçiçek et al., 2007 and literature listed).

The **Hora Fm** conformably overlies and probably interfingers with the upper part of the Mavradzei Fm. In order to avoid confusion, our usage of the Hora Fm follows Meissner (1976) and Weidmann et al. (1984) but is extended and includes Spiliani limestones as well. Thus, Hora Fm starts with a series of white-grey thick-bedded to massive fresh-water limestones, changing to marly limestones intercalated with thin beds of greenish tuffaceous silts (Fig. 3); the depositional environment corresponds to a sub-littoral shallow water lake facies. Its thickness varies from ~20 m near Mavradzei village to >50 m between Hora and Pythagorion villages (Spiliani Hill). The formation continues gradually upwards with a thick series of white-yellowish thin-bedded to laminated fresh-water limestones with intercalations of clayey marls including volcanoclastic material and casts of Helicidae indet. (small size), Hydrobiidae indet. and ostracods. This series presumably represents deeper lacustrine environment. The thickness of the upper series reaches 200 m NE of Mavradzei village (Figs 3, 4). The type section of the Hora Fm is situated along the Pythagorion-Hora-Mytilinii road (Fig. 4). As in the Mytilinii Basin, the alluvial fan-deposit phase of several western Anatolian basins (Söke-Kusadasi, Denizli, Demicri, Çubugludağ, Yatağan/Kale) is succeeded by a shallow to deep lacustrine facies resulting in the deposition of thick to thin bedded alternations of sandstones, mudstones and limestones of basically late Miocene age (Gürer et al., 2001; Genç et al., 2001; Yağmurlu et al., 2004; Alçiçek et al., 2007); in some parts of the neighboring areas this environment continues into the Pliocene.

All previous subdivisions of the Neogene deposits of the **Mytilinii Basin** consider the clastic fossil-bearing sediments exposed around Mytilinii village as a separate unit, the Mytilinii Fm, which overlies the lacustrine limestones of the Hora Fm (Tab. 1). The nature of the contact between these two formations remains, however, an open issue as it is thought to be either normal (van Couvering & Miller, 1971; Meissner, 1976, Kostopoulos et al., 2003) or unconformable (Angélier, 1976; Theodoropoulos, 1979; Weidmann et al., 1984). During our investigations, this contact has been recognized in two sites, the "Kalathi" stream and at "Theopiito Gefyri", located south and west-northwest of Mytilinii village respectively. In both these sites there is a normal contact between the two formations, sometimes marked by a tuffaceous gritstone

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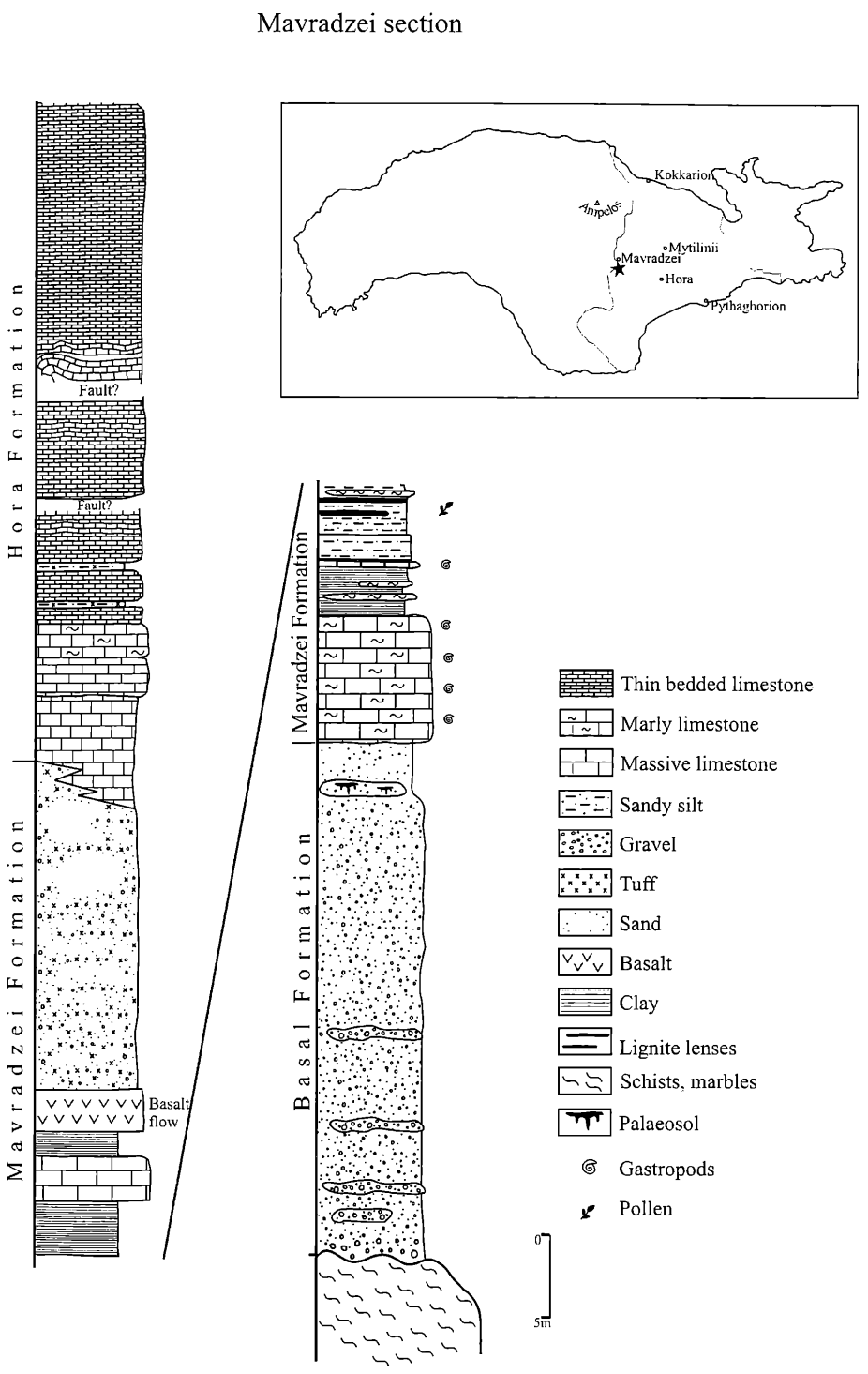

Figure 3: Composite stratigraphic column (Mavradzei section) of the lower Neogene deposits of Mytilinii Basin, Samos, indicating Basal Fm, Mavradzei Fm and the lower part of Hora Fm.

(Fig. 6). Several authors suggested that the presence of pebbles originating from the Hora Fm in the Mytilinii Fm indicates an erosional phase before the deposition of Mytilinii Fm and thus, a hiatus between these two units. However, the pebbles from the Hora Fm occur in the middle part of the Mytilinii Fm (the White Beds member of WEIDMANN et al., 1984) interrupting its lithological continuum. Hence, the erosional phase cannot be correlated to the boundary between Hora Fm and Mytilinii Fm, which is dated to 8.6 My (KOSTOPOULOS et al., 2003). It is quite possible that during the deposition of Mytilinii Fm, at ~7.5 My (which is more or less the age of the White Beds; see KOSTOPOULOS et al., 2003; KOUFOS et al., this volume) tectonic movements uplifted the marginal south-eastern part of the basin exposing the upper part of Hora limestones to erosion and thus providing the material deposited in the Mytilinii Fm. It is worth mentioning in this context that the upper layers of Hora Fm often show slumps (Fig. 7). Moreover, the Hora limestones or corresponding deposits in the Karlovassion basin are dipping steeply in several sites confirming the presence of a tectonic phase (PAPANIKOLAOU, 1979).

The Mytilinii Fm outcrops mainly in the central and northern part of the basin and includes all known fossiliferous mammalian sites. It mainly consists of fluvial to fluviolacustrine, volcanoclastic to clastic deposits and has a thickness of about 300 m. The lithology of the Mytilinii Fm in the two thick sections of Mylos and Dromos is given in detail (Figs 8, 9). WEIDMANN et al. (1984) recognized four members in the Mytilinii Fm from base to top: the Old Mill Beds and Gravel Beds (Fig. 8), consisting of green-brown silty sands rich in tuffaceous clasts and calcareous concretions, alternating with sandy tuffs, gritstones and conglomerates, make up the lower part of the formation. The White Beds member (Fig. 8), consisting of white marls and marly-sandy limestones is succeeded by alternations of sandy marls with white limestone breccia and conglomerates with clasts originating almost exclusively from the Hora Fm; the Main Bone Beds member (Fig. 9) consists of brownish to reddish silty sands with lenticular intercalations of white tuffites, and yellow-brownish conglomerates and tuffaceous sandstones with calcareous concretions. The sandy marls occasionally bear moulds of land snails and palaeosols with nests of

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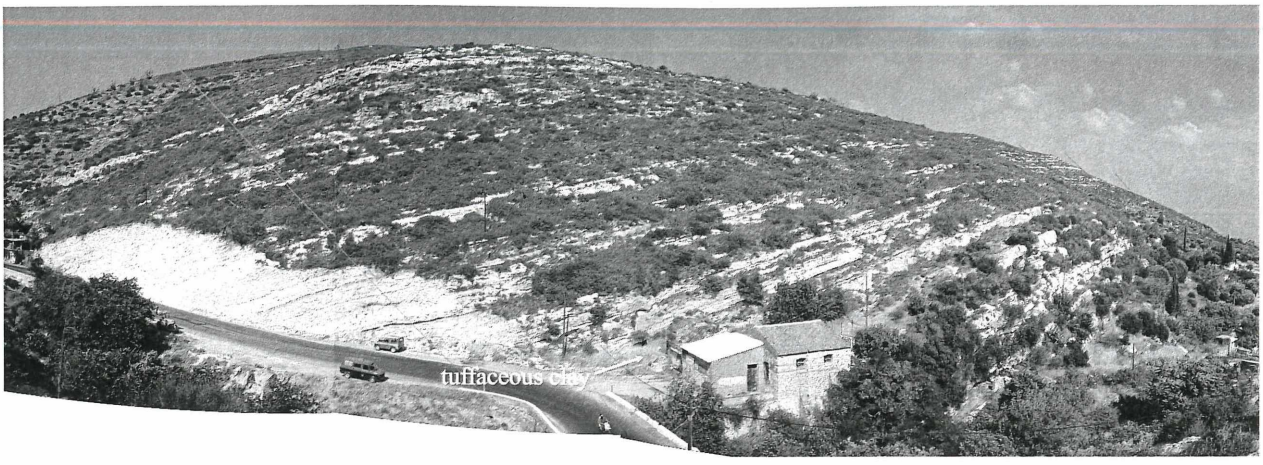

Figure 4: Hora section; thin- laminated limestones of Hora Fm, north of the homonymous village.

masonry wasps (Fig. 5b). In the fossiliferous sandy clays of the Adrianos ravine, moulds of *Helix* sp. (large size globular shell), Helicidae indet. and *Ena* sp. have been also found (Fig. 5c, d, e). The characteristic Marker Tuffs at the top of the formation (Fig. 9) consist of red tuffaceous sandy silts with intercalations of massive tuffs. Although this subdivision is well recognizable in the field, the contacts between the members can rarely be traced because of extensive faulting. The depositional environment of Mytilinii Fm roughly corresponds to subaerial hyperconcentrated flows in complex with ephemeral lake and overflow deposits. According to magnetostratigraphic and radiometric data (Weidmann et al., 1984, Swisher III, 1996; Kostopoulos et al., 2003) the base of the Mytilinii Fm is dated at ~8.6 My. Since the Vallesian-Turolian boundary is dated at 8.7 My (Steininger, 1999) the Hora Fm is referred to Vallesian and the Mytilinii Fm to the Turolian stage (Kostopoulos et al., 2003; Koufos et al., this volume). The Mytilinii Fm has no direct counterpart in the surrounding western Anatolian basins, probably because of the differentiated depositional conditions in distinct sub-basins during Turolian. Generally, it seems that during late Miocene fluvial/alluvial conditions are more frequent in the north-western Anatolian basins than in the south-western ones where the lacustrine sedimentation might continue up to the Pliocene.

The youngest Neogene lithostratigraphic unit, the **Kokkarion Fm**, conformably overlies the Mytilinii Fm (Tab. 1; Figs 9, 10). This formation has a considerable expansion in the northern hilly ridge of the Mytilinii basin. It is mainly composed of shallow lacustrine thick bedded to massive white-yellowish fresh-water travertine-like limestones, alternated with green-brown clays and tuffaceous sands. A vertical as well as, a lateral transition between the upper horizons of the Mytilinii Fm and the superimposed Kokkarion Fm has been observed in many places. The Kokkarion limestones reveal a travertine texture with plant remains, vertical casts of Phragmites stems, oncoids and permineralized shells of the turriform gastropod *Brotia* cf. *graeca* (Fig. 5f, h), which could be considered as the "characteristic" fossil of the Kokkarion Fm. The age of the formation is estimated as Latest Miocene to Pliocene.

In summary, the lithostratigraphy of the Neogene deposits of the Mytilinii Basin is (see Fig. 11):

- **Basal Fm**: Red-brown sands, gravels and conglomerates (Early-Middle Miocene).
- **Mavradzei Fm**: Thick lacustrine limestones rich in gastropods with intercalations of organic clays. A basalt flow and volcanoclastic deposits of lahar type occur in the upper part of the formation (Middle-Late Miocene).
- **Hora Fm**: thick to thin-laminated lacustrine limestones with intercalations of thin beds of tuffaceous clays (Late Miocene-Vallesian).
- **Mytilinii Fm**: Brownish-reddish fluviolacustrine volcanoclastic deposits including the mammal sites (Late Miocene-Turolian).
- **Kokkarion Fm**: Alternating yellowish-white lacustrine limestones, green-brown clays and tuffaceous sands (Latest Miocene-Pliocene).

3. Fossiliferous Sites of the Mytilinii Basin

The number and the names used in the literature to indicate the fossiliferous sites in the Neogene deposits of the Mytilinii Basin are confusing because the relocation of sites excavated by different workers, over more than a century, is in many instances uncertain. In the past this has been leading to conflicting conclusions. For this reason we decided to give new names to all the fossil sites (re)discovered by us, even if we had convincing evidence that a site coincides with an old quarry; the coordinates of all sites are available on request. Since the main problem concerning the various Samos collections across the world is their lack of stratigraphical information, we performed an extensive correlation between new and old fossil sites updating and improving previous efforts (Solounias, 1981, Kostopoulos et al., 2003).

New fossiliferous sites: Our fossil prospecting at Samos started in 1994 in the Adrianos ravine (Fig. 10), which is by far the richest and best known fossil area in the Mytilinii Basin (Forsyth-Major, 1888, 1891, 1894; Solounias, 1981). Moreover, one of us (G.D.K.) had excavated there

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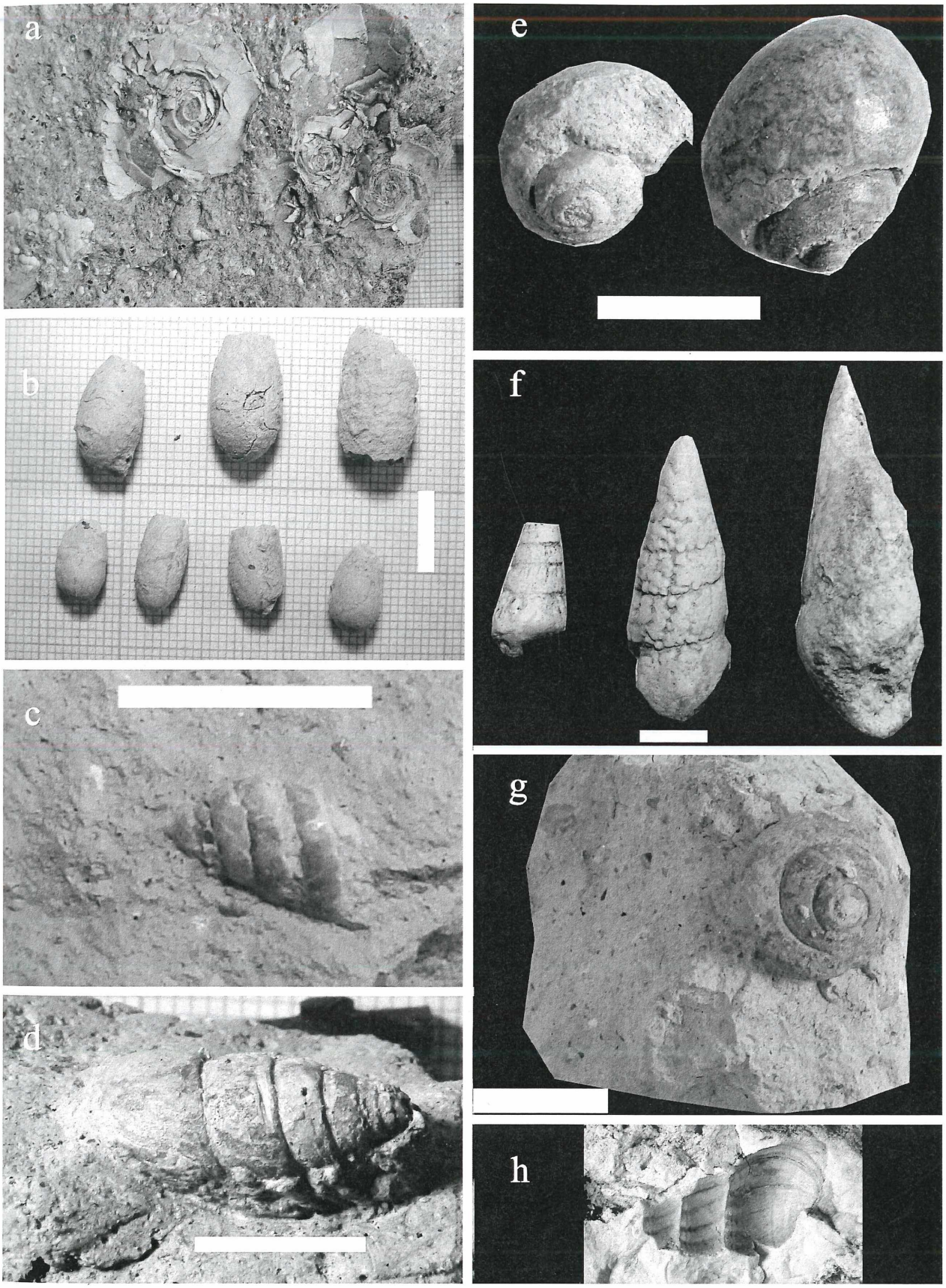

Figure 5: Fossil invertebrates from Mytilinii basin, Samos. a. *Planorbis* and Hydrobiidae indet. in Mavradzei limestones; b. casts of masonry wasps nests in the upper levels of Mytilinii Fm; c. Helicidae indet. in tuffaceous sandy silt of Mytilinii Fm, Adrianos ravine; d. *Ena* sp. from Mytilinii Fm, Adrianos ravine; e. *Helix* sp. (large size) from Mytilinii Fm, Adrianos ravine; f. *Brotia* cf. *graeca* from Kokkarion Fm; g. ?*Helicella* sp. sandstones exposed in the new marina of Pythagorion below limestones of Kokkarion Fm; h. cast of *Brotia* sp. from Kokkarion Fm, top of Stefana hill. Scale-bar equals 10 mm.

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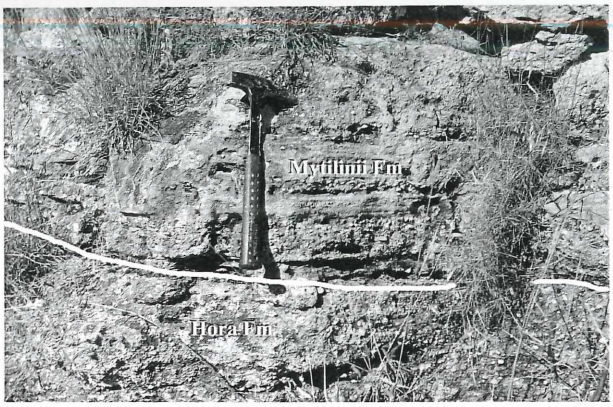

Figure 6: Contact between the Hora and Mytilinii Fms at the "Kalathi" stream, southwestern of Mytilinii village.

Figure 7: Typical slumps of the thin-laminated limestones of Hora Fm, exposed near the monastery of Timios Stavros.

Mylos section

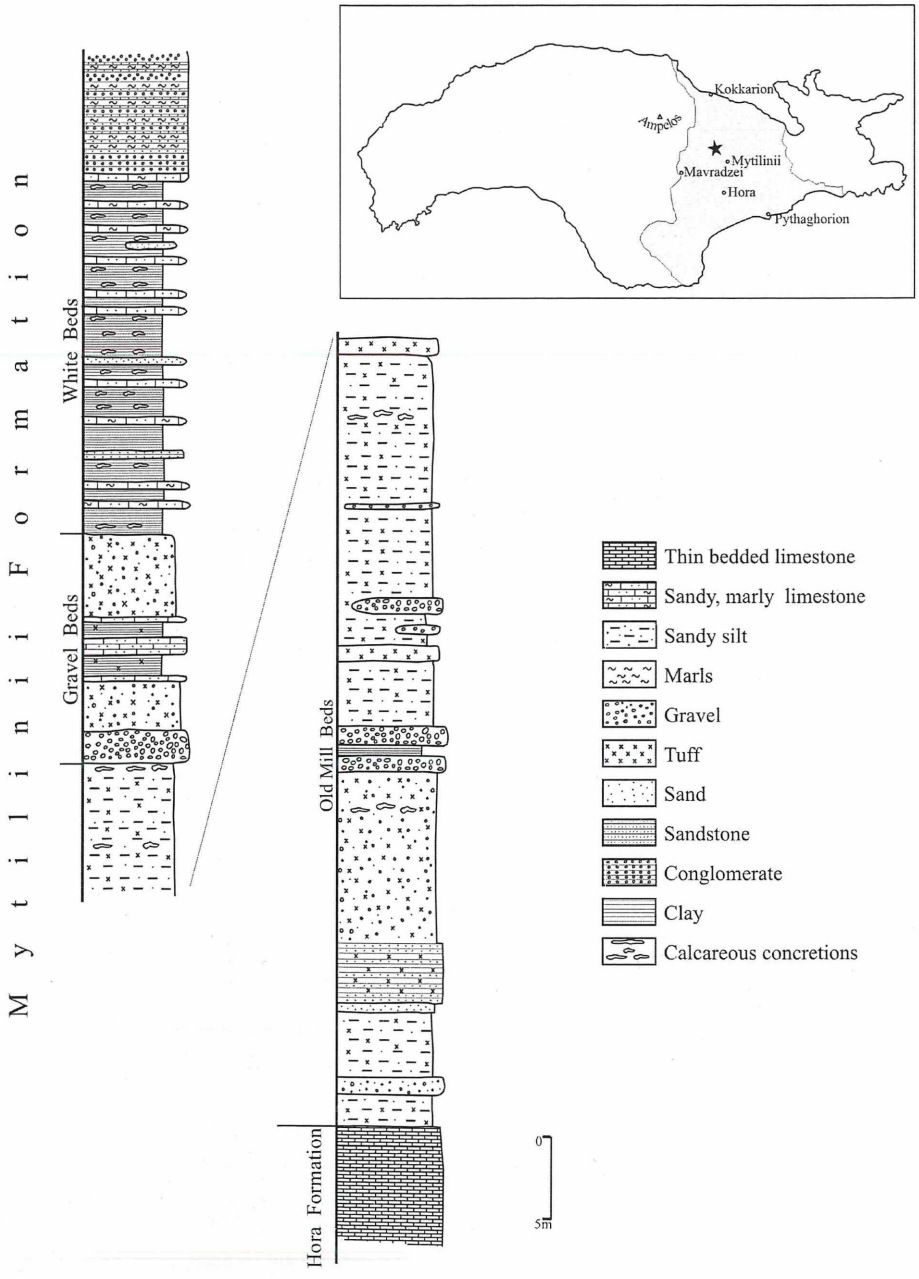

Figure 8: "Mylos" stratigraphic column of the upper Neogene deposits of the Mytilinii Basin, Samos, indicating the basal-median part of Mytilinii Fm in contact with Hora Fm.

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during the 1985 expedition of Prof. J. Melentis. Five different fossiliferous sites have been found in the Adrianos ravine; four were announced by Koufos et al. (1997) and one was traced later. The first site we excavated, named Mytilinii-1A (MTLA), coincides with J. Melentis's "Adrianos" or "Stefanidis" (Melentis, 1969; Koufos & Melentis, 1982, 1984). A large part of the collection in the Paleontological Museum of Mytilinii, Samos (PMMS) comes from this site. MTLA locality (Fig. 12a) is situated at the bottom of the ravine near the base of the north-western slope. Some 40 m to the south and at the same stratigraphic level as MTLA, but at the opposite side of the ravine, is our new fossil site Mytilinii-1C (MTLC, Fig. 12b). About 15 m above MTLC, on the south-eastern banks of the Adrianos ravine the new and quite rich site Mytilinii-1B (MTLB) was found during the opening up of a dirt-road to reach MTLA (Fig. 12c). A few meters above MTLA the leftovers of an old excavation were retrieved (Fig. 12a). Among the debris of that site, named Mytilinii-1D (MTLD), several complete bones of large mammals were gathered. A few meters north of MTLD and more or less at the same level, the new locality Mytilinii-1E (MTLE) was discovered in a small side ravine. MTLE is probably the most northern fossil-pocket of the MTLD level. Thus, two distinct fossiliferous levels can be recognized in the Andrianos ravine: a lower one represented by

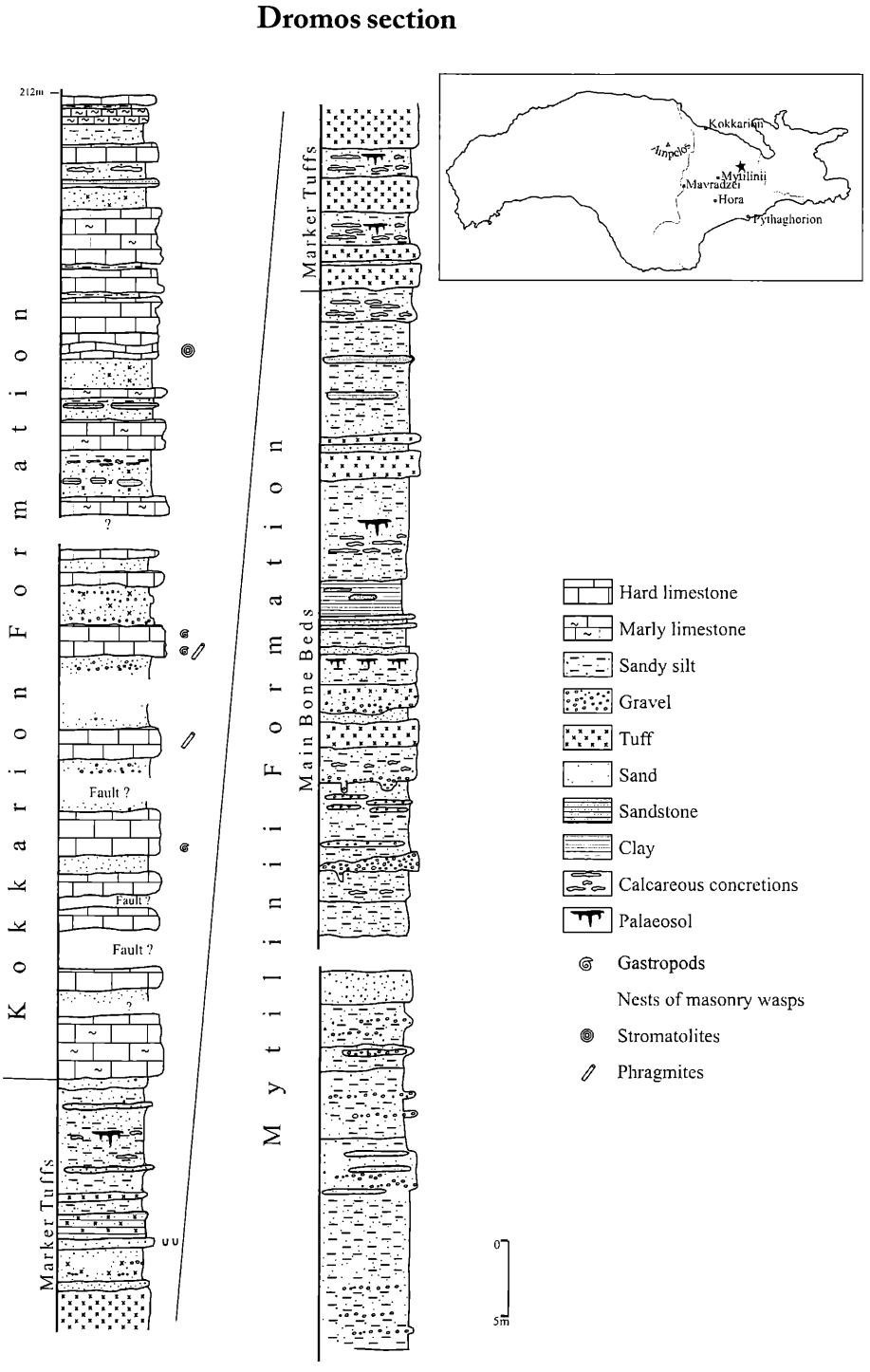

Figure 9: "Dromos" stratigraphic column of the upper Neogene deposits of the Mytilinii Basin, Samos, indicating the upper part of Mytilinii Fm in contact with Kokkarion Fm.

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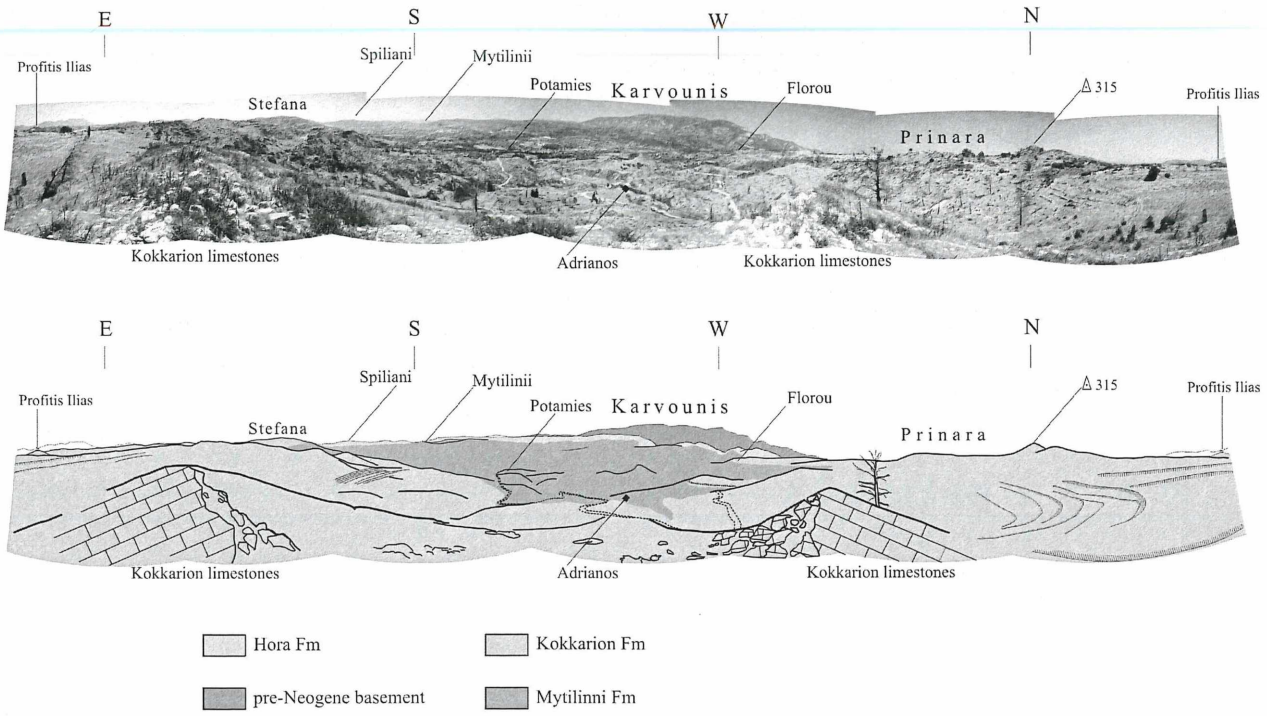

Figure 10: Panoramic view (360°) of the Mytilinii Basin, seen from the hills northeast of Adrianos ravine.

MTLA/C and an upper one represented by MTLB/D/E (Koufos et al., 1997; Kostopoulos et al., 2003:fig. 13). Two fossil sites were found along the Potamies ravine, in the central part of the Mytilinii basin. One of these, Mytilinii-3 (MYT), is located at the junction of a small stream and the northern bank of the Potamies ravine, just below the Megalos Vrachos hill (Fig. 12d). Although we collected several fossils at this site, the lens was quickly exhausted and our efforts to find other concentrations in the surrounding area were unsuccessful. The other site, Mytilinii-4 (MLN), is situated on the southern slope of the Potamies ravine, opposite of MYT and about 300 m south-eastern from the junction point of the Adrianos and Potamies ravines (Fig. 12e).

At the northern limit of Mytilinii Basin, 500 m northwards of Adrianos ravine, another new site was recently discovered at the beginning of the Tholorema stream (Fig. 12f). This site, Mytilinii-5 (MTN), is situated near the village of Kokkarion. Unfortunately we did not excavate there yet, so the few fossils collected are surface finds.

Correlation with the old quarries and stratigraphy (see Fig. 11): Among early scientists and other people who collected fossils on the island, only C. I. Forsyth-Major and B. Brown gave sufficient topographic indications of their quarries to allow their correlation with the local stratigraphy and the new fossil sites. Schlosser (1904) discerned Samos fossils on the basis of their matrix and colour, but apart from a few characteristic layers (i.e., "braunen Tuffen", "weisslichen kalkigen Ablagerungen") that are easily recognized in the field, these indications prevent a safe link with stratigraphy.

The Forsyth-Major's collection at the University of Lausanne (MGL collection) is labeled as "Adriano", "Stefano" and "Potamies", all representing local names (Fig. 10). The greater part of the collection at the Natural History Museum in London (NHML), created by Forsyth-Major during the 1889 expedition (Solounias, 1981:33) is indicated as originating from "Vryssoula". "Adriano" certainly refers to the Adrianos ravine, the main fossil-bearing area on Samos that is stratigraphically in the upper part of the Mytilinii Fm, the so-called Main Bone Beds Member (MBB) of Solounias (1981) and Weidman et al. (1984). The label "Stefano" obviously refers to the foot of Stefana hill, located NNE of the Mytilinii village. Although this site was not re-discovered, its topographic location is affiliated with the lowermost part of the MBB. Forsyth-Major's "Potamies" suggests reference to the Potamies stream where several sites were found later. The deposits in this area belong to the middle part of the Mytilinii Fm, including the White and Gravel Beds (WB, GB) and the base of the MBB of Weidmann et al. (1984). Finally the "Vryssoula" sample at the NHML most probably comes from the NNW limits of Mytilinii village, where tuffaceous clays predominate, suggesting a correlation with the lower part of the Mytilinii Fm, i.e., the so called Old Mill Beds Member (OMB) of Solounias (1981) and Weidmann et al. (1984).

B. Brown marked the sites he excavated with the prefix Q (quarry) followed by a letter or a number. He mentioned seven fossil sites (Qx, Q1-6). The material collected by B. Brown is housed at the American Museum of Natural History (AMNH). Solounias (1981) and Weidmann (1984) made an extensive effort to relocate the B. Brown quarries and their respective position in the stratigraphy of the Mytilinii Basin.

Qx is geographically located at the northern limit of Mytilinii village (Solounias, 1981), an area that lies within the borders of a military campus at present. The

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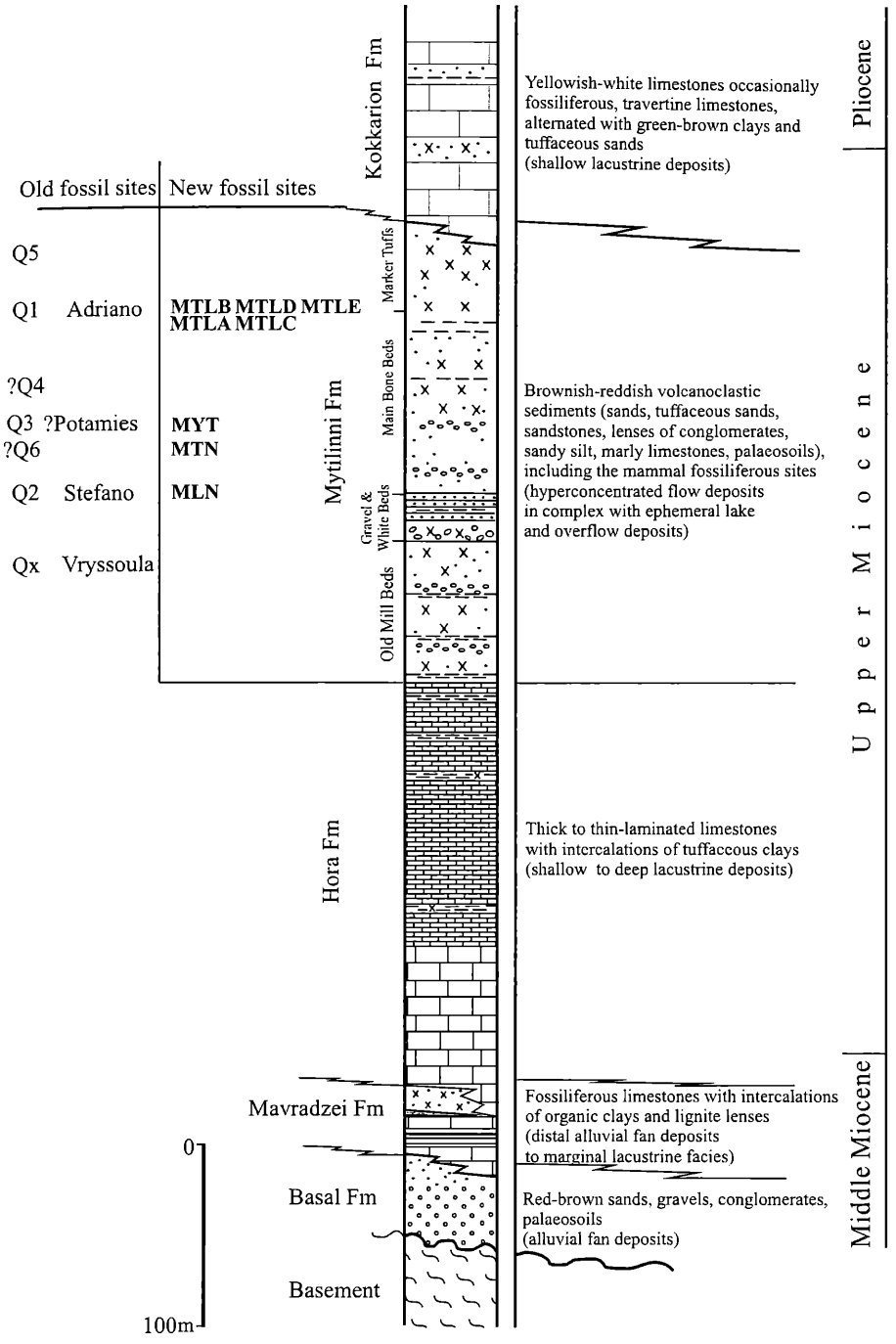

Figure 11: Composite stratigraphic column, indicating the lithology, chronology and sedimentary environments of the Neogene deposits of Mytilinii Basin, Samos, as well as the stratigraphic position of the old and new vertebrate fossil sites of Mytilinii Fm.

topographic location is identical to that of Forsyth-Major's "Vryssoula" locality. During the summer of 1998, some fragmentary fossil material was collected from the volcanoclastic beds cropping out in this part of the basin. SOLOUNIAS (1981) and BERNOR et al. (1996) put Qx 10 m above the base of the Mytilinii Fm, but our data (KOSTOPOULOS et al., 2003) shows that this fossil horizon belongs to the middle-upper levels of WEIDMANN's (1984) Old Mill Beds Member.

Brown's Q1 is located in the Adrianos ravine (SOLOUNIAS, 1981). Using the illustrations of BROWN (1927:figs. 14, 15), KOSTOPOULOS et al. (2003) directly correlated Q1 with MTLD. These sites, as well as, "Adriano" of Forsyth-Major and MTLA, MTLB, MTLC and MTLE are stratigraphically placed in the upper part of the Mytilinii Fm (upper MBB member) (KOSTOPOULOS et al., 2003).

SOLOUNIAS (1981) located Brown's Q2 and Q3 on the northern slopes of Potamies ravine. Q3 is placed at the base of the Megalos Vrachos hill (SOLOUNIAS, 1981). This position fits perfectly with the new site MYT (KOSTOPOULOS et al., 2003). Their stratigraphical position is in the lower horizons of the main fossiliferous part of the Mytilinii Fm (basal-middle MBB member). The site S4, where SOLOUNIAS (1981) collected micromammals, is probably at the same level and in close proximity.

According to SOLOUNIAS (1981), Q2 is situated 15 m NW of the junction of the Potamies and Adrianos streams on the northern slope of the Potamies ravine. The remains of an old excavation are still visible there, but our effort to collect new material was unsuccessful. The exposed fossil-bearing layers are placed in the lower-middle part of the main fossiliferous beds of Mytilinii Fm (basal-middle

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Figure 12: The new vertebrate fossiliferous sites of Mytilinii Fm. a. Mytilinii-1A (MTLA) and Mytilinii-1D (MTLD); b. Mytilinii-1C (MTLC); c. Mytilinii-1B (MTLB); d. Mytilinii-3 (MYT); e. Mytinilii-4 (MLN); f. Mytilinii-5 (MTN).

MBB member). The micromammal localities S2 and S3 (Solounias, 1981) are placed a few meters higher. Following topographic information by previous authors (Solounias, 1981; Weidmann et al., 1984; Bernor et al., 1996) Kostopoulos et al. (2003) correlate Q2 with Q3/MYT, but this strongly opposes the results coming from the study of the Q2 mammal assemblage at the AMNH, which indicates an age earlier than that of MYT and closer to that of MLN and "Stefano" (Kostopoulos, this volume-a, b). It therefore became evident to us that this confusion should concern the geographic position of Q2.

Our locality Mytilinii-4 (MLN) is situated at the very top of the lower fossiliferous part of Mytilinii Fm, in the thin calcitic-marly layers that correspond to the White Beds member of Weidmann et al. (1984). The geographical and stratigraphical position of MLN fits information given by Solounias (1981) for the position of B. Brown's Q4, but the Q4 mammal assemblage at the AMNH contradicts this correlation because it seems to be younger and closer to Q1 (Kostopoulos, this volume-a, b; Vlachou & Koufos, this volume). A possible explanation for this discrepancy could be that the location of Q4 was for some reason confused with that of Q2 and vice versa. The corrected position and correlation of old and new fossil sites is given in Fig. 11.

The Q5 site of B. Brown and the locality L of the late 19th century consul Acker are localed in the Limitzis district (Solounias, 1981). The Q5 site has been re-discovered in 1994 and a few surface fossils have been gathered. Kostopoulos et al. (2003) discussed its stratigraphic position and suggested that it is situated in the uppermost part of the Mytilinii Fm, just below the Marker Tuffs

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(MT) member of Solounias (1981) and Weidmann et al. (1984). The location of B. Brown's Q6 on the eastern slopes of the Tholorema valley at the northern limit of Mytilinii Basin (Solounias, 1981) matches that of our site Mytilinii-5 (MTN). The study of a few recently collected fossils and the Q6 sample at the AMNH collection allow us to change our previous suggestion concerning the chrono-stratigraphic position of the site (Kostopoulos et al., 2003). Q6/MTN undoubtedly includes *Samotherium major*, suggesting a younger age than the associations from Qx, Q2, MLN and "Stefano" and no older than 7.4 My (Kostopoulos, this volume-a).

4. Conclusions

The review of the Neogene deposits of the Mytilinii Basin, Samos, allows recognizing five successive formations: The Basal Fm of coarse clastic sediments, and the Mavradzei Fm of fossiliferous limestones and clays with lignites, represent the older deposits in an extensive lacustrine system that developed in the western Anatolian - eastern Aegean region during the Early-Middle Miocene. During the Vallesian the shallow to deep lacustrine limestones of the Hora Fm where deposited into this system. The conditions on Samos became more fluvial during the Turolian, leading to the deposition of the volcanoclastic Mytilinii Fm with the famous mammal sites. Marginal tectonic movements in the western part of the basin exposed part of the Hora limestones during the deposition of Mytilinii Fm, providing the calcareous clastic material present. Shallow lake conditions were then quickly restored in the area and the Pliocene travertine-like limestones of Kokkarion Fm were deposited.

New vertebrate fossil sites of the Mytilinii Fm, have been described and correlated with the classic fossil quarries and the local stratigraphy, leading to an updated and more reliable version. Five successive fossil horizons have been recognized ranging from 8.0 to 6.7 My.

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