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LATE CENOZOIC PALEOGEOGRAPHY AND FAUNAL SUCCESSION OF MAMMALS IN CRETE

By

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Introduction

The geologic evolution of the South Aegean area and especially the Hellenic arc, is complex and related to the wider area of the Eastern Mediterranean.

The evolution of Crete and the surrounding south Aegean sea areas, can be classified into three main large tectonic periods:

The first period (late Burdigalian-late Serravallian) is characterised by a rotation towards the South and along a fault-zone with E-W direction.

The second period of late-Tortonian up to the early-Pliocene is characterised by the cutting into pieces of the island of Crete and the forming of a non-symmetrical mosaic with horsts and grabens, which are oriented along the basic faults that were mentioned before.

During the third period (early-middle Pliocene), a general northward rotation took place, which is connected with the occurring transgression of the Pliocene sea. During this period the later shape of Crete was defined.

As far as the paleogeography is concerned, during the Middle and Late Miocene, Crete was part of the mainland and connected to Minor Asia. In the Pliocene, Crete broke in small islands, while in the Pleistocene, Crete got its present shape.

For land mammals the most obvious obstacle is water, like channels, straits or wider seas. It is clear that this changing paleogeography has consequences for the evolution and dispersal of mammals.

The Paleogeographic Framework

On faunal composition it is possible to distinguish two different types of fauna, the first one impoverished and the other which has clearly a mainland stamp.

Dermitzakis & Sondaar (1979) distinguished the following routes:

*** Άνω-Καινοζωϊκή Παλαιογεωγραφία και διαδοχή της πανίδας των Θηλαστικών στην Κρήτη.**

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1) A corridor in which faunal interchange from one region to another is possible.

2) A filter spread is probable for some animals but indefinitely improbable for others.

3) A sweepstake spread is impossible for most and very improbable for some, but does occur accidentally.

4) The pendel route; a route which is easily crossed by some mammals, but an insurmountable barrier for others.

The corridor can be a broad land connection. A filter may be a landbridge, while the sweepstake route may be caused by a wider sea. A smaller water barrier may be crossed easily by good swimmers, which barrier can be used by some mammals for round voyages in both directions.

The faunal evolution of a region depends highly on the possible dispersal route. If there is a corridor to the continent, the fauna will not differ essentially from other parts of the continent, but if an island becomes populated by sweepstake dispersal, only very few taxa will reach the island and when survival is achieved, there will evolve an endemic fauna with very few taxa (unbalanced).

The other way round, if we find an endemic unbalanced fauna, we can suppose that the animals had lived on an island and that their ancestor had reached it by filter dispersal of sweepstake route; in other words there existed a wide sea barrier between the mainland and this island. In other words, if we analyse a fossil fauna we can draw certain conclusions about the paleogeography and there are of course several possibilities:

1. If we find fossils that indicate a balanced fauna similar to the mainland and we find this fauna on an island, it means that the present island must have been connected by a corridor with the mainland in the past.

2. A somewhat impoverished, balanced fauna can have several explanations, such as restricted environment, a disconnected landmass or a dispersal route which is possible for most animals, but for some an insurmountable obstacle (filter bridge).

3. An unbalanced endemic fauna points to the conclusion that the barrier was a broader sea barrier, crossed only occasionally by some animals (swimming, drifting on natural inlets). Also here it is clear that the swimmer would have a better chance to cross. As such crossing are an exception, it is possible that a population would get isolated and an endemic form could evolve. The fauna contains only a very limited number of endemic species, descendants from an ancestor which reached the island by the sweepstake route.

If we take into consideration the mammal fauna of Crete, we can distinguish two types, which can be explained by the paleogeography:

1. The Miocene fauna (Van der Made, 1996, in press) which is similar to the mainland fauna of Eurasia. The dispersal route must have been a corridor.

2. The Pleistocene fauna impoverished endemic and unbalanced, when Crete was isolated (Reumer, Willemse, and De Vos, 1996, in press). A dispersal which must have been due to a sweepstake route indicates that Crete was an island at that time and the ancestors of the Pleistocene fauna reached the island by the sweepstake route.

The geological evolution of the South Aegean area and specifically the Hellenic arc, part of which forms the island of Crete, is related to the geodynamic realm of the wider area of the Eastern Mediterranean, where the Hellenic arc holds a key-position. In order to understand the sedimentation and the tectonic evolution of Crete, during the Late Cenozoic Era, it is important to take into consideration its relation with the broader area and the results of the geological researches not only in Crete, but also in its surrounding area.

The relevant behaviour of the African and Eurasian plates during the geological time must be considered as an essential factor for its evolution (fig.1). The Mediterranean area comprises a complicated contact zone between these two plates. The character and the type of the contact zone (horizontal dip slip, subduction) is not obvious in the western and central part of the Mediterranean sea. On the contrary, along the Hellenic arc there is strong evidence - especially this arising from dynamic geology and seismology - in order to assume that lithospheric subduction is taking place in the Eastern Mediterranean under the Aegean area (where along with Crete-Peloponessus, the Ionian islands and the Hellenic arc are also included).

As the movement of the African plate in relation to the Eurasian one has been almost annihilated, the subduction must be interpreted as an active dip-slip of the Aegean lithosphere on top of that of the Mediterranean Sea. Structures and phenomena known from the large submergence zones (e.g. taphrogenetic and volcanic arcs) are also observed in the Aegean area (fig.1).

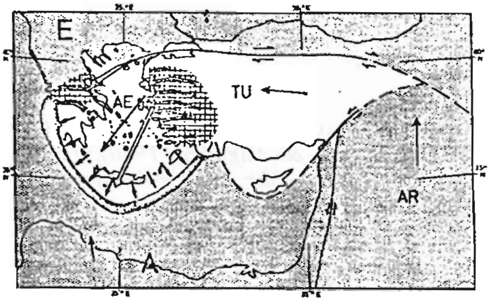

Fig.1; *Schematic representation of the plates and their movements during the Plio-Quaternary, according to Mckenzie (1972). The thin black arrows point at the strikes of the movements in relation to the Eurasian plate. The Arabian plate compresses the Eurasian one like an unbending tongue (Tapponier & Molnar, 1976). Thus, the plates of the Aegean and the Anatolia are being pushed westwards. The white arrow points at the movement of the Aegean plate towards the African one. According to Brunn (1977) these composite movements are quite possibly the continuation of the pre-Pliocenic strikes. The confused boundaries are marked with convergent lines. The Aegean compression zone is marked with black and the volcanoes with black dots. As we can see from the black arrows, the Aegean area is expanding towards the eastern Mediterranean.*

The behaviour of the Aegean lithosphere must not be confused with the behaviour of an unbending part. Offshore geophysical and volcanic research have proved that the Aegean bottom is clearly cut into pieces by normal faults. In addition, the neotectonic studies of several continental areas have proved the same thing. A result of this "cut into pieces" process is leading to McKenzie's model (1978), the so-called "Degeneration

Biozones of the micro- and macro-fossils, the vertebrate findings and the Geochronologic scale (fig.4), through studies of the Stratigraphic Units of the Neogene and Quarternary on the continental and marine areas of Crete.

During the Neogene and the geochronological periods of the late-Burdigalian, the Serravallian, the boundary of Serravallian-Tortonian, the Late-Miocene (Tortonian/Messinian and Messinian) and the early-Pliocene, radical changes took place in the paleogeographic and sedimentary evolution of several Cretan basins and sub-basins. Some of these events are comparable with similar ones that were observed in the Hellenic arc, during the period of the Eocene-Oligocene, although the last events lack in biostratigraphic data as they consist only of coarse grained sratigraphic units (Dermitzakis *et al.*, 1978.).

During the period of the late-Eocene-early-Miocene times, that was about 36-21 million years ago respectively, the most important events observed was the filling of the basins with coarse grained detrital materials, originating from neighbouring carbonate banks, as well as the impending turbidity gatherings of them. Detailed observations can be made on the Ionian and Preapulian zones in the north and west part of the Hellenic arc, while in the South Aegean these can be partly observed due to the fact that the units of this period are allochthonous (Dermitzakis & Papanikolaou, 1981).

During the early Eocene - early Miocene period, uplift and erosion took place in the area of Crete so that the materials of erosion of the limestones gathered in the created basins and constituted the sediments of the "Prina complex" with blackish calcareous conglomerate- breccia of shallow environment.

During the early Miocene-middle Miocene period, that is about 21-14 million years ago, basic changes occurred in the general palaeogeographic configuration of the broader area. This is due to the tectonic events of the Burdigalian compression about 18 million years ago, with the overthrust nappe on the Alps mountain range, on the one hand and closing up of the Mediterranean sea with the Indian-Pacific in the Middle East on the other hand (Adams *et al.*, 1983). Such allochthonous units originating from the Pindos series overthrust on the Ionian one, have been noticed in Crete (Meulenkamp, 1982) and in the Western Greece (Dercourt, 1977, De Mulder, 1975, Nikolaou, 1985). A detailed study showed that the folding ascention and the partial erosion of the before the upper Burdigalian sediments in the Ionian zone corresponds to an isoclinal fold along the eastern margin of the Preapulian zone (Bonneau, 1984, Papanikolaou, 1984).

In the late Burdigalian - early Langhian, 16.5-15.5 million years ago approximately, a general reorganization has been noticed all over the Mediterranean and on the Paratethys (Rögl & Steininger, 1983). In particular in the western Hellenic arc a new transgression and deposition of sediment on the folded sequences of the Ionian zone was observed. At the same time, the tectonism of discompression changed to one of extension along the margin of the Preapulian zone resulting to the sudden alteration from the calcareous marly to clayey sediment (Dermitzakis, 1978). During the same period an uplift of several metres of the sea level, took place as it has been proved by the study of benthic foraminifera in Western Greece (De Mulder, 1977, Van Der Zwaan, 1986). During this period the fault-creating tectonism that took place, gave a new profile or caused a renewal to the old one in several areas of Crete and especially in the area of Aghios Nicolaos, Ierapetra and Chania. At the same time calcareous breccia of the "Prina complex" and conglomerate of the "Tefelion Group", were deposited.

In the middle Miocene - late Miocene times, that is 15-16 million years ago, certain defining events of the whole evolution of the South Aegean (Kythira, Crete, Karpathos, Kassos, Rhodes) took place. So, the tectonic events of Serravallian, 14-12 million years ago, caused remarkable renewal of the profile. The island of Crete was embedded in a general submergence relevant to the large scale tilted movement towards the south.

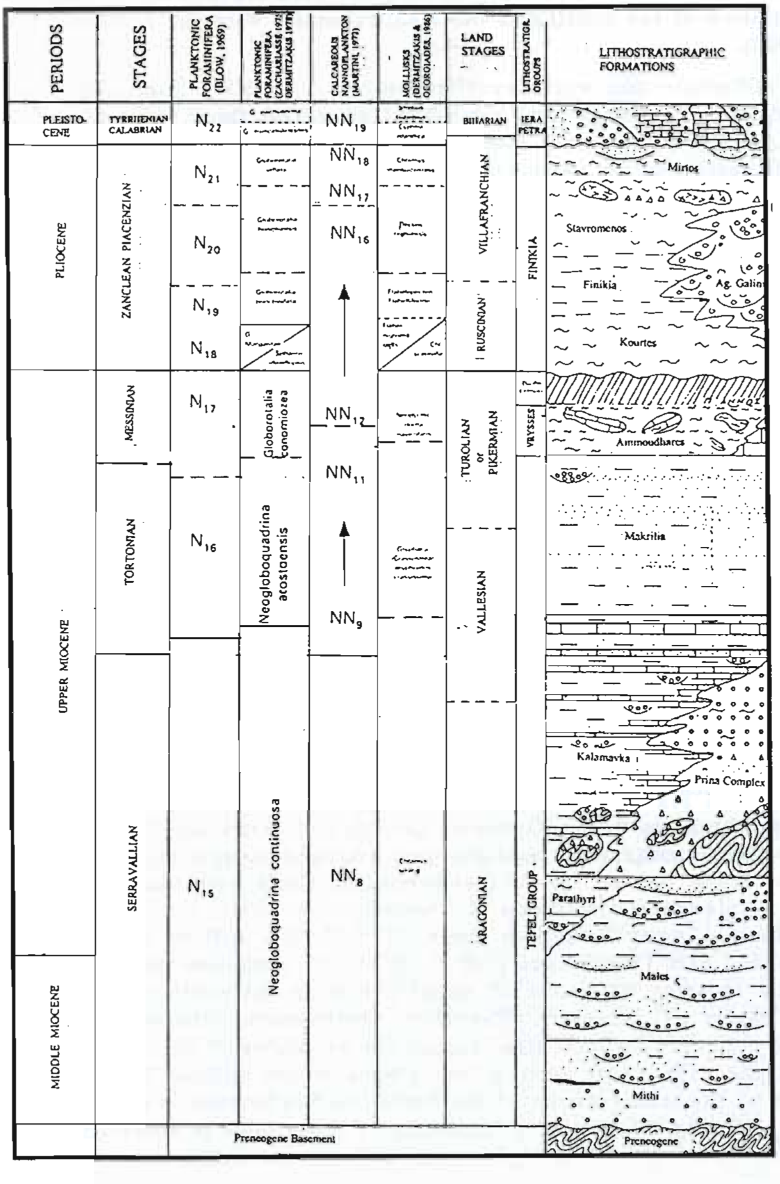

Fig. 4; *Correlation table of the biozones of marine sediments, pollen and mammals that have been recognised in Crete, and chronostratigraphic development of the lithostratigraphic units of Crete.*

During the same period the existing fauna and the conditions of sedimentation are shaped according to the environment, that followed the discontinuation of communication of the Mediterranean with the Paratethys (Rögl & Steininger, 1985) and the limitation of the binding of the Mediterranean, with the Atlantic (Van Der Zwaan *et al.*, 1986).

The sediments that were deposited during this period (fig.5) are characterised by high sedimentary energy with some hundred metres thick sediments of the "Tefelion Group" (conglomerate, sand, clay). During the Serravallian the material that supplied the sedimentary basins came from territories north and east of Crete (Meulenkamp, 1971).

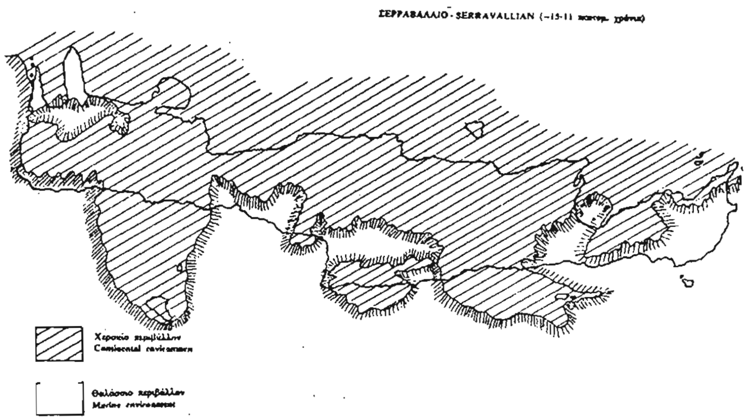

Fig. 5; *Palaeogeographic sketch of Crete during the Serravallian. The shadow lined areas show the continental land.*

During the Serravallian-Tortonian period, approximately 11, 9-11, 11.6 million years ago, the palaeogeographic configuration changed completely in the South Aegean. Thus, the South Aegean fallow that connected Crete with the main Balkan peninsula started to plunge (Dermitzakis & Papanikolaou, 1981). In Crete, during the upper Serravallian - lower Tortonian times (11, 9-11, 11.6 million years) according to the stratigraphic data (Meulenkamp *et al.*, 1979) the tectonism that took place had as a result the creation of basins of about the same morphology to those of the main present basins of Ierapetra, Heraklion, Rethymnon, Gheorghioupolis, Chania and Kissamos (fig. 6). This tectonism, caused the beginning of the creation of the Hellenic arc, and the subsequent cutting into pieces of the fallow. In Crete, break up was followed by the transgression of the Tortonian Sea between 8 and 9 million years ago. In general during this period a flattening of the profile is observed which is verified by the overthrust of several Alpine beds of Tortonian sediments.

During the same period, the uplift of the Arabian plate led to the disconnection between the Eastern Mediterranean and the Indian Pacific, but at the same time the terrestrial communication between Eurasia and Africa is a fact. Then the Hipparion migrated from Asia through Europe to the Iberian Peninsula and from Asia through Iraq to north Africa, as well as through Asia Minor to the Aegean territory. In Greece, many places accompanied with fauna of the Hipparion species are known - like the ones of Chios, Psara, Samos, Pikermi, Almyropotamos, Alatini etc. On the hill of the

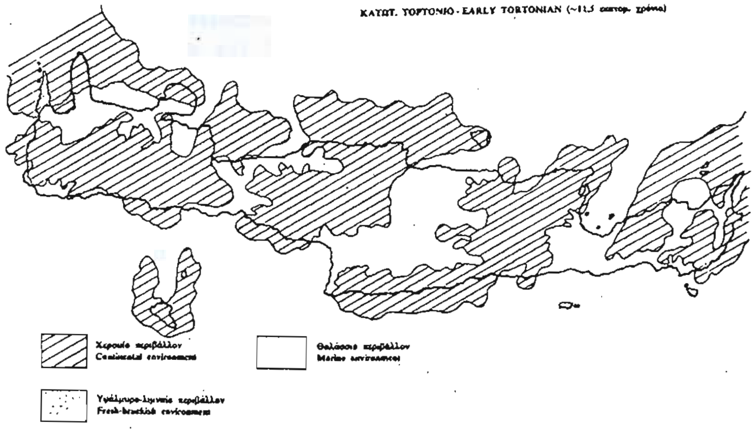

Fig. 6; *Palaeogeographic sketch of Crete during the early Tortonian. The shadow-lined areas show the continental land, the dotted areas show the island basins (of fresh or brackish water). The sea coverage is shown by white.*

village Kastelliana in Heraklion-Crete, remnants from *Hipparion muscardinus, Progonomys woelferi, Progonomys cathalai* etc. were found, aged 10.3 - 11.4 million years (Sen *et al.*, 1985). This fauna presents similarities to that in the Valessian, of Spain (De Bruin *et al*, 1979). Similar to that of the Hipparion fauna has been found in the section Petra in Sitia with remnants of the genus Microstonyx (Leinders & M. Meulenkamp, 1978). The above-mentioned mammals used to live in the valleys and forests, as well as in the existing shallow lakes and marshẹs of Crete. Remains of Mastodon were also found in middle-Tortonian beds in Vrysses-Gheorghioupolis (Benda & Symeonidis,1974). The forest and the flora that had been developed during this period show a temperate to sub-tropical climate, warmer than the present one.

During the late Miocene, that is approximately 6-5 million years ago, the fault-creating tectonism of blocks with tilted movements of uplift and erosion, shaped these sub-basins in the South Aegean, with local submergencies and shallow chalky deposits, aged about 5.6 million years (Langereis *et al*, 1984) (fig.7).

During Messinian times, the uplift of the mounts of South Spain and North Africa, that had started in the middle Miocene, was completed so, the communication between the Mediterranean and the Atlantic was limited. About 6 million years ago this communication was broken resulting to the "Salinity Crisis" of the Mediterranean (Cita 1978, 1982). All the Mediterranean had a drainage per basin and some of these basins were filled with evaporited beds of large thickness. So, in a duration of 500.000 years about 1 million cubic km of gypsum and anhydrites must have been deposited. The kind and the size of those gatherings shows a non-stopping marine environment of small depth of stromatolites, foliation of algae and gypsum crystallites (Rouchy & Mondy, 1981). As a result of the "salinity crisis"and the tectonic activity closed "seas"-lakes of low salinity were created, where the endemic Pontian fauna with Congeria, Limnocardium, Melanopsis and a number of other gastropodes was developed. The renewal of the profile that came after, may be was caused not only by the salinity crisis and the tectonism, but also by possible glacial eustatic movements during the Messinian (Hsu et al., 1973). In Crete, it was also observed that during the Messinian

(Meulenkamp *et al.*, 1979) a reorganisation of tectonism took place, a thing which was concluded by the characteristic distribution of the upper Messinian sediments. This inter-Messinian tectonic reorganisation is possibly related to compressional tectonics. Thus, uplifts and erosions of a part of the old Neogene sediments were observed. Local submergences with thin-bedded brackish sediments were stated along with red.conglomerate, sand and clay in several places.

During lower-middle Pliocene times (5-3.4 million years ago) the Pliocenic transgression took place, filling with water the drained- during the Messinian basins and creating in hard lines the new Mediterranean sea. On the other hand during early Pliocene times an uplift of the Hellenic arc along with an increased regression of the inner Aegean area involved. This compression was followed by local transgressions and changes of facies. In Crete different vertical movements were observed (marine-breccia; Fortuin, 1977). The uplifts in the island of Crete were interrupted during the upper part of the middle Pliocene (3-2.5 million years ago) and that was when sediments were deposited in several sections of the island; (Keratokampos,Tsoutsouras, Castelli, Heraklion, Ierapetra, Sitia, Goudouras, Koufonissi, etc.) (fig.8).

The sediments deposited during the early-middle Pliocene mostly consist of marl, marly limestone and sand with a plentitude of micro-and macro-fossils. The above mentioned inter-Pliocene event has to do with more general movements of the Eurasian and African plates (Steininger & Rögl, 1984). The Pliocenic sediments of Crete were deposited in several small basins, in opposition to the Miocene ones. Nevertheless, during the early Pliocene, we can say that homogeneous sediments were more or less deposited all over Crete, due to uniform predominant conditions of the Pliocenic transgression. These sediments consist

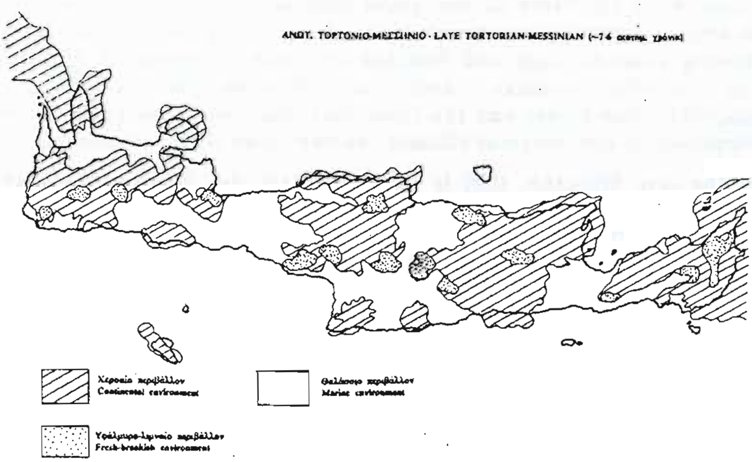

Fig. 7; *Palaeogeographic sketch of Crete during the late Tortonian. The shadow-lined areas show the continental land, the dotted ones the lakes (of fresh or brackish water) and the sea intrusion is shown with white*

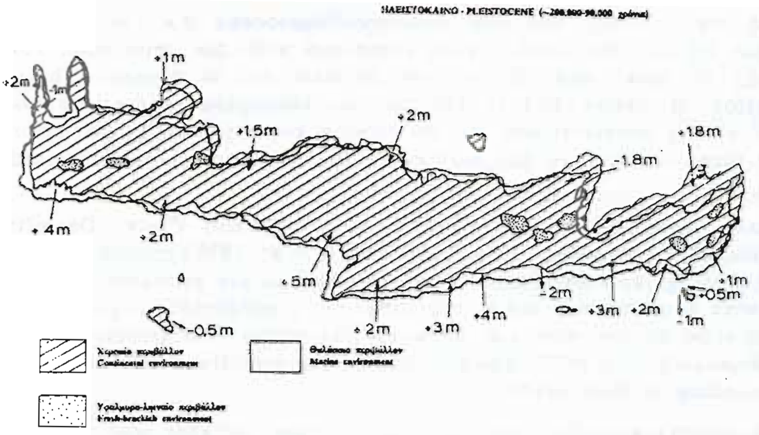

Fig. 8; Palaeogeographic sketch of Crete during the Pliocene. The geographical border and tectonic lines are meant to be developed from the lower Miocene, and tectonic activity is continued. Thus, the sketch presented above must be considered as a developing model. The shadowed parts represent terrestrial areas and the dotted ones lakes or lagoons.

mostly of calcareous marls with planktonic foraminifera and thin-shelled molluscs. Only in the marginal areas of the basins, the clastic sediments of the lower Pliocene are restrained.

With the beginning of the Pliocenic sedimentation the difference of tectonic evolution and sedimentary history between the several small basins becomes recognisable. The above mentioned vertical movements resulted to the reinstallation of the lower Pliocenic and older neogenic sediments, forming, thus, the marly breccia. This breccia was transported and deposited into deeper sections of several basins and at these positions formed the base of Pliocene. At the beginning of the middle-Pliocene some areas of Crete started uplifting and the marine sedimentation stopped, like for example in Chania and central Heraklion. Marine sedimentation continued in the north and south areas of the island. Finally, during the early-middle Pliocene we have a lot of small sub-basins that are either connected or separated by shallow bridges. In these sub-basins of Crete, lamellar sapropels and sediments with diatomites were deposited, exactly over the marly breccia.

The late-Pliocenic sediments in Crete are limited in narrow zones on the southern and northern side of the island (fig.8).

From a lithostratigraphic point of view the Pliocenic sediments belong to the lithostratigraphic unit "Phinikia Group" which is represented by several formations, like Myrtos (E. Crete), Kourtes, Phinikia, Stauromenos (Heraklion), Dramia, Asteri, Frangocastello (Rethymnon), Zounaki (Chania) (Meulenkamp *et al.*, 1979).

Based on the studies of the O^{16}/O^{18} isotopes on foraminifera from several localities of the Mediterranean and Crete, Zachariasse & Spaak, (1983) came to the conclusion that the warm and stable Pliocenic climate was succeeded by a very cold interval about 3.2-3.3 million years ago. These climatic alternations caused considerable glacial-eustatic changes on the level of the sea.

In this way, during the late Pliocene-Pleistocene we can observe successive alternations on the sea level, which combined with the tectonism, formed Crete's morphology of today and that of the Hellenic arc in general. This led up to a redistribution of basins and to tropical morphological alterations with changing periods of strong subaerial and marine erosion accompanied by variations of the sea level. All these resulted to the moving of the unconformably deposited Quaternary sediments.

The data from the Ionian islands (Zakynthos) and Crete (Dermitzakis, 1973a, Dermitzakis, 1973b, Angelier, 1979, Dermitzakis *et al.*, 1979) proved a repeated rotation eastwards; during the Pleistocene. These movements are probably the continuation of the clockwise rotation that led to a gradual but considerable regression of the basins from both sides of the Arc, e.g., between Zakynthos -Peloponessus, Crete -ridge of Chryssi (Nesteroff *et al.* 1977). The Quaternary terraces are classified generally in three groups according to their height.

The chronostratigraphic classification of these terraces was achieved either by frequency fossils (for bibliographic data see Dermitzakis, 1973a, 1973b) or with carbon dating (Angelier, 1979b, Pirazzoli *et al.*, 1981). The highest terrace is about 250.000 years old and the lowest about 50.000 years old (Neotyrhenian). These three characteristic terraces are not of course found in the same level, especially along the southern coasts of Crete (fig.9). The reasons for this are, on one hand the above mentioned eastward rotation and on the other hand the tilted movements of fault blocks that complicate the height of several terraces or old sea-surfaces (Dermitzakis, 1972, 1973a). We can be led to these conclusions after studying the Pleistocenic terraces, old shorelines, beach rocks, ancient tombs, Roman fish reservoirs, not only of the coasts of Crete, but also of all the islands of the southern Hellenic arc. After studying man-made buildings Flemming (1978, 1981) concluded that the average value of movement of the coast, reaches up to 100 cm/ 10000 years, but because of the complexity of this phenomenon his conclusions are not universally accepted.

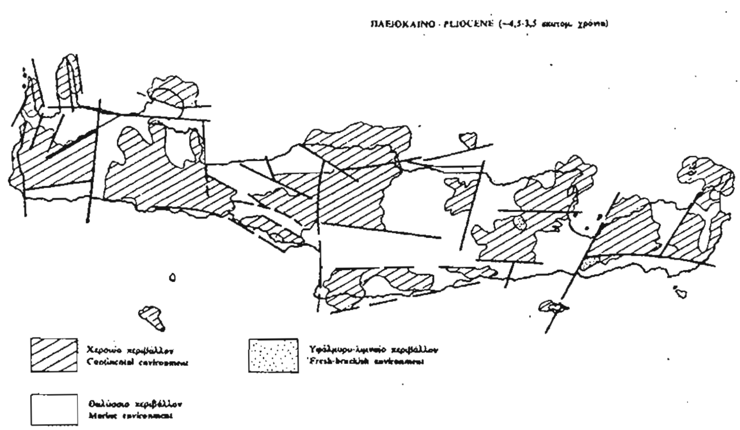

Fig. 9; *Palaeogeographic sketch of Crete during the Pleistocene, that shows the fallow (shadowed) and the lakes (dotted) existed during all Pleistocene, but developed in combination with the glacial and inter glacial periods and the tectonic activity.*

The study of the Quaternary mammals that were found, proved that in the terrestrial environment of Crete the biotope and the way of living and developing of several groups of mammals was related to climate alterations, tectonic events that happened and to the palaeogeographic configuration of the island (Dermitzakis & De Vos, 1986).

The micromammals *Kritimys* and *Mus* lived in an environment of fresh water and their feeding consisted mostly of hard food. Turtles, birds, serpents and fresh water fishes, lived also with them.

The most recent of the dwarf hippos that were found in Katharo lived 12.135+-485 years ago (Bachmayer *et al.*, 1984). Recent radiodatings gave an age of 585 years ago (Reese, pers. comm.). The altimeter of Katharo reaches 1200 metres. In that way the *Hippopotamus* was adjusted to climbing and walking in inaccessible places. It is probable that hippos visited the lake of Katharo during summer at interglacial periods because during winter it was covered with snow, and then he hibernated in coastal caves that were ideal shelters against cold and heat.

The dwarf elephants were adjusted to a temperate climate in valley or forest environments. As time passed by the reduction of food and climatic changes led to smaller sizes and finally to their disappearance.

Three deers lived, generally, in forest environment, were small sized and ate hard food. The different sizes and characteristics of the Cretan deers of the *Candiacervus* genus show that they lived in a different environment. Some of them lived in the forests of that age, but used to run in the valleys eating grass, and others lived in drier places eating only the soft green branches of the bushes. The voyaging from place to place, ecological conditions and the order and rate of arrivals from emigrations resulted to the development of eight different types of *Candiacervus* (Dermitzakis & De Vos, 1986).

Except from the hawks and vultures who hunted small rodents, the only carnivore mammal found until today in Crete during the Pleistocene is the water-snake *Isolalutra cretensis*. It lived in swampy areas and small lakes. It used to eat ostracoderms, small rodents and anything it could catch. That is the reason why its teeth had a special form completely different from that of the water-snake of today.

Acknowledgements

The author wishes to thank Dr. M. Triantaphyllou and H. Drinia (Athens University) for their valuable suggestions on its improvement.

Σύνοψη

Η γεωλογική εξέλιξη της νότιας περιοχής του Αιγαίου και ειδικότερα του Ελληνικού τόξου, σχετίζεται άμεσα με το γεωδυναμικό καθεστώς της ευρύτερης περιοχής της Ανατολικής Μεσογείου. Η σχετική μετακίνηση της Αφρικανικής και Ευρασιατικής πλάκας κατά τη διάρκεια του γεωλογικού χρόνου, θεωρούνται ο πιο σημαντικός παράγοντας που επηρεάζει την εξέλιξη αυτή.

Η εξέλιξη της Κρήτης, καθώς και των περιοχών του νότιου Αιγαίου, διακρίνεται σε τρεις μεγάλες τεκτονικές περιόδους : Η πρώτη περίοδος (Αν. Βουρδιγάλιο - Αν. Σερραβάλλιο) χαρακτηρίζεται από μια περιστροφή προς νότον καθώς και κατά μήκος μιας ζώνης ρήγματος διευθύνσεως Α-Δ.

Η δεύτερη περίοδος (Αν. Τορτόνιο - Κατ. Πλειόκαινο) χαρακτηρίζεται από τον κατακερματισμό της Κρήτης σε μικρότερα τμήματα και τον σχηματισμό μωσαϊκού αποτελούμενου από τάφρους και κέρατα.

Κατά τη διάρκεια της τρίτης περιόδου (Κατ. - Μ. Πλειόκαινο), μια γενική προς βορράν περιστροφή έλαβε χώρα η οποία συνδέεται με την επίκλυση της θάλασσας κατά το πλειόκαινο. Κατά τη διάρκεια αυτής της περιόδου διαμορφώθηκε το τελικό σχήμα της Κρήτης.

Όσον αφορά στην παλαιογεωγραφική εξέλιξη της περιοχής αυτής κατά τη διάρκεια του Μ. και Αν. Μειόκαινου, η Κρήτη αποτελούσε τμήμα της ενδοχώρας και ήταν ενωμένη με την Μικρά Ασία. Κατά το Πλειόκαινο, η Κρήτη χωρίστηκε σε μικρότερα νησιά, ενώ κατά το πλειστόκαινο, έλαβε την τελική της μορφή.

Σχετικά με τα χερσαία θηλαστικά, το πιο σημαντικό εμπόδιο για την μετακίνηση τους είναι το νερό. Είναι φανερό ότι οι μεταβολές της παλαιογεωγραφίας είχαν επιπτώσεις στην εξέλιξη και την διασπορά αυτών των θηλαστικών.

Η εξέλιξη της πανίδας μιας περιοχής εξαρτάται κυρίως από τις πιθανές διαδρομές διασποράς. Πιο συγκεκριμένα για την πανίδα της Κρήτης, διακρίνονται δύο είδη τα οποία εξηγούνται με βάση την παλαιογεωγραφία :

1. Η Μειοκαινική πανίδα η οποία παρουσιάζει πολλές ομοιότητες με την πανίδα της Ευρασιατικής ενδοχώρας, και
2. Η Πλειστοκαινική πανίδα η οποία είναι ενδημική και παρατηρείται στην Κρήτη όταν αυτή είχε πια απομονωθεί από την ενδοχώρα.

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