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ΠΑΛΑΙΟΟΙΚΟΛΟΓΙΚΟΙ ΠΑΡΑΓΟΝΤΕΣ ΠΟΥ ΕΞΑΣΦΑΛΙΣΑΝ
ΤΗΝ ΕΠΙΒΙΩΣΗ ΚΑΙ ΤΗΝ ΠΡΟΣΑΡΜΟΓΗ ΤΩΝ ΑΝΘΡΩΠΩΝ
ΤΟΥ ΠΛΕΙΣΤΟΚΑΙΝΟΥ ΣΤΑ ΝΗΣΙΑ



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PALEOECOLOGICAL FACTORS THAT CONTROLLED THE SURVIVAL AND ADAPTATION OF THE PLEISTOCENE MAN ON THE MEDITERRANEAN ISLANDS*

by

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I. INTRODUCTION

Man colonized islands relatively recently, in the Neolithic period. However, in some cases migration of hominids across sea barriers must have occurred much earlier. Colonization of islands has been well-investigated (AZZAROLI, 1979, 1981, DIAMOND, 1987b, GOTELLI & GRAVES, 1990, GUENTHER, 1988, HIGGS, 1981, HOREGGER, 1966, HOOIJER, 1967a, b, KEEGAN & DIAMOND, 1987, KUSS, 1973, 1975, MCARTHUR & WILSON, 1967, SIMBERLOFF, 1974, STRID, 1971).

An island's rate of colonization varies according to its size, its proximity to other land, upon climatic conditions, temperature and currents of the surrounding sea, on the biological, edaphological and geological resources of the island, and on the capacities and needs of plants and animals, including humans to exploit these resources. If an essential resource is overexploited, colonizers will have to adapt to the new conditions or else disappear.

Palaeoecological conditions on islands led to the development of faunas with dwarfed species, showing a low gear locomotion due to lack of large carnivores (LEINDERS & SONDAAR, 1974). Dwarfs of large mammals, such as elephant, deer and *Hippopotamus* are often present. Their presence in the monotonous endemic island faunas can be explained by the good swimming capacity of their mainland ancestors.

This pattern is also found on islands outside the Mediterranean, including Japan and the Indonesian Archipelago (HOOIJER, 1975, SONDAAR, 1977, 1981, AZZAROLI, 1982).

Paleontologically, there are no reliable traces of hominids on the Mediterranean island prior to Upper Pleistocene *Homo s. sapiens*. Archaeologically, there is evidence for the presence of *Homo* on Sardinia in the Middle Pleistocene.

The aim of this paper is to review the mammal faunal pattern of the Mediterranean emphasizing to the islands of Crete, Cyprus, Milos and Sardinia and to set the paleo-ecological factors which controlled the survival of Paleolithic Man in these islands.

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II. FAUNAL PATTERN

Fossil Quaternary mammals are known from several islands of the Mediterranean and especially from Aegean archipelago.

It is evident that in a region like the Aegean with all its islands, the composition of the fauna depends greatly on which animal could come where and when, especially in the case of land mammals for which a sea is mostly an insurmountable obstacle. DERMITZAKIS & SONDAAR (1978) distinguished four possible dispersal routes:

1. A corridor in which faunal interchange from one region to another is possible.
2. A filter dispersal where spread is probable for some animals but definitely improbable for others.
3. A sweepstake where spread is impossible for most and very improbable for some animals, but does occur accidentally.
4. The pendel route, a route which is easily crossed by some mammals but an insurmountable barrier for others.

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 ancestors had reached it by waif dispersal or sweepstake route; in other words there existed a wide sea barrier between the mainland and this island.

The endemic mammals from islands underwent changes from the moment they became isolated on the island, and it might be assumed that there is some correlation between the degree of changes and the time of being on the island in a different environment.

One major factor determining the composition of insular faunas is the presence or absence of terrestrial carnivores. Larger carnivores are generally absent from endemic island faunas (so-called unbalanced faunas). The explanation is of course that large carnivores are worse swimmers than the mammals usually present in such faunas (ruminants, elephants, hippopotamus, see SONDAAR, 1977; DERMITZAKIS & SONDAAR, 1978).

The islands of the Mediterranean are well known for their unbalanced endemic Pleistocene mammalian faunal structures. It is clear that the endemic island mammals must have had close relatives on the mainland.

Of the larger mammals we find only those with good swimming ability (elephant, deer, *Hippopotamus*).

Today's elephants are excellent swimmers. One then should not be surprised that Upper Cenozoic elephants reached Sardinia (AMBROSETTI, 1972), Sicily (BURGIO *et al.*, 1988), Cyprus (BATE, 1904, SWINY, 1988), Malta, Crete, Serifos, Delos, Naxos, Tilos and Rhodes in the Mediterranean.

Hippopotamus does not need land-bridges to reach islands. In Mediterranean they reached Cyprus (BATE, 1904, BOEKSCHOTEN & SONDAAR, 1972, SIMMONS, 1988a, b), Crete (BOEKSCHOTEN & SONDAAR, 1972), Malta, Sicily (BURGIO *et al.*, 1988), Sardinia (ESSA & KOTSAKIS, 1988) and probably most other Mediterranean islands (Reese, 1975).

Furthermore, endurance, small size, living in and around trees made possible for animals like mice, rats, dormice and insectivores to reach the island by drifting on wood,

islets, etc.

On the islands the animals underwent changes that made them more adaptable to island life. The most striking products of such seclusion are gigantic forms of formerly small vertebrates like rodents or flightless birds, and dwarf forms of originally large animals like elephants, hippos and cervids.

The dwarfing of large animals is readily understood. The limited territory and food resources on an island favour a reduction in body size- the smaller the animals become the more likely they are to survive.

Gigantism in island reptiles and rodents is probably due to the reduction of carnivorous enemies. Islands support only small terrestrial carnivores.

A further aspect of island endemization is a reduction in birth rates. In the absence of carnivores, population densities of herbivores are limited by trophic factors and occasional natural disasters.

On the Mediterranean islands, dense populations of Pleistocene dwarf elephants, hippos, cervids, bovids (*Myotragus*) or ochotonid like *Prolagus* must have had a devastating effect on the vegetation. Hungry elephants eat just about everything (BARNES, 1983, KORTLANDT, 1976, MULLER-DUMBOIS, 1989, OTTICHILO, 1987, SMART *et al.*, 1985), and *Myotragus* with its rodent-like incisors did not come in a bad second. Grazing hippos prevent the formation of river-side forests (FRADRICH, 1968).

The fewer the species that are involved, and the more efficient their dentition, the quicker the deforestation (ADAMS, 1975, MENSCHING, 1990). If newly arrived or introduced herbivores do not have their numbers controlled by carnivores, woods disappear within the lifetime of the local trees and are replaced by invading grasses and shrubs.

The dense green woods of the Pleistocene that some botanists constructed for the Mediterranean islands seem to be no more than wishful thinking. These woods were doomed when the first elephant, hippo or deer appeared.

The best thing that ever happened to these woods was the arrival of man, who devoured the unwary herbivores populating the islands. The devastated vegetation of the islands certainly offered even less vegetable food, suitable for primates, than on the continents.

The disappearance of insular faunas when they are brought into contact with continental faunas is a normal phenomenon: the more competitive forms displace the highly specialized forms from their niches.

Crete

Crete is part of an island-arc of non-volcanic origin which probably owes its formation to the subduction of Mesozoic ocean-bottom under the Aegean part of the European megaplate (JACOBSCHAGEN, 1986). It is unlikely that Crete was ever connected to the mainland in the last 5 million years. It was isolated by deep canyons during the Messinian Salinity Crisis, and the Sea between Crete and Cycladic Islands is far too deep to have been drained during Pleistocene low sea levels.

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

1. The Miocene fauna (VAN DER MADE, 1996) 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) arrived when Crete was isolated (DE VOS, 1996, WILLEMSSEN, 1996, REUMER, 1996) indicating that

Crete was an island at that time and the ancestors of the Pleistocene fauna reached the island by the sweepstake route.

It is clear that the Pleistocene fauna of Crete only contains cervids, hippos, murids, shrews, elephants, birds and reptiles, while large carnivores, with the exception of the otter are lacking (DERMITZAKIS & DE VOS, 1987). The cervids are by far the most widely represented and widespread forms, while hippopotamus and elephant remains are fewer (SONDAAR *et al.*, 1996). The latter are present in two forms of different size. The smaller, *Elephas creticus*, is older and is found in the *Kritimys kiridus* zone (MAYHEW, 1996). Some authors report the presence of a form, with a size comparable to that of *Elephas antiquus* (LAX, 1996).

The mammals found in Crete were endemic, which means that they were restricted to Crete itself. The endemic unbalanced fauna points to isolation of Crete during the Pleistocene (DERMITZAKIS, 1990). According to SONDAAR & BOEKSCHOTEN (1967) and DERMITZAKIS & SONDAAR (1978) the mammals, including the cervids, reached the island by swimming or drifting. Pleistocene artifacts of Crete are not known, there are no large murids that could support paleolithic Man. Further there are no indications that Man lived together with the endemic island fauna neither indications that man tried to domesticate the island mammals.

The extinction of the endemic cervid *Candiacervus* must have been caused by Neolithic Man who took with him domestic animals. This we can deduce from the finds of the section Gerani 2; above the main layer Ge2, in which we find only *Candiacervus* there is a layer without species, but with traces of human activities. In this layer *Mus minotaurus* is still present. There is no clear sedimentary break between this layer and the layer Ge2. The extinction of *Candiacervus* must have taken place in the Holocene, with the arrival of Man, about 8000 BP. The somewhat later extinction of *Mus minotaurus* probably was caused by competition of *Rattus* and recent *Mus*, which accompany every human invasion. Based on the data given above it is very unlikely that *Homo sapiens* colonized Crete before 8000 BP.

The original endemic mammal faunas on Crete became extinct due to anthropogenic factors such as hunting, attempted domestication, predation by introduced carnivores, competition with introduced species, and habitat destruction. The extinction process on the islands was certainly not a sudden process, but one that took several millenia. This has several reasons. In the first place, introductions by man of other mammal species did not happen at once. Furthermore it will have taken different lengths of time for different species to respond to the changes in their environment.

In 1987, FACCHINI & GIUSBERTI claimed to have rests of a skull from *Homo sapiens sapiens* discovered by SIMONELLI in 1893 in the island of Crete, which was dated by the method of Protoactinium/Uranium at an age of 51.000 ± 12.000 years. The question arise if Crete fulfilled the requirements mentioned above and if the supposed colonization of Crete by Man in the Pleistocene can be effected.

Cyprus

The animals reached Cyprus from the mainland by swimming; smaller animals may have reached the island by rafting on floating vegetation or trees. Even during the Pleistocene glaciations, when sea levels were at their lowest, Cyprus remained separated from the nearest mainland shore, the now submerged Gulf of Alexandretta on the coast of Turkey, by at least 30 km. Today the closest coast is 69 km away.

The reason for such animal migration is not clear, but it may have been due to over-

population on the mainland and/or decreased availability of food sources. Over time, these pygmy forms descended from their normal-sized mainland ancestors. The small size of these once-large mammals gave them greater mobility in the mountainous island environment. It also enabled them to utilize their food sources more efficiently, thus permitting a larger population.

Exactly when such animals arrived on Cyprus is also not yet clear; geological observations suggest it was probably some time in the later Pleistocene, between 250.000 and 100.000 years ago.

The fossil pygmy mammals were first scientifically studied by Bate over 90 years ago. The fossils were re-examined by the Dutch scientists 20 years ago. Several new fossil sites have been found since 1988.

Recently, much attention has been refocused on these animals because of the discovery of an eroded rockshelter, known as Aetokremnos, on the coastal cliffs of the Akrotiri RAF base in the south. Here pygmy hippos and pygmy elephants are found with bird and snake bones, numerous marine shells and, for the first time, with manmade stone tools and stone and shell ornaments.

Many of the bones have been burnt by man, and several crude hearths and pits have been recognized. This site is dated by a suite of Carbon-14 dates with an average of about 8500 BC or around 10.000 years ago. This is about 2000 years earlier than man was thought to have been present on Cyprus, during the Aceramic Neolithic period.

To date, this has been the only undisputable evidence of coexistence of Pleistocene large mammals with man on a Mediterranean island

Milos

On Milos island the remains of a dwarf elephant were recognized as well as a molar belonging to *Equus caballus*. The presence of *E. caballus* may be linked to the presence of an uppermost Pliocene-Low Pleistocene landmass west of Milos and the possible connection of the present day island to the mainland towards the west.

It is known that the opsidiane found in geological beds of the Mesolithic period in the Frahtsi cave in Argolidha province, was coming from Milos. The discovery of opsidiane in a distance of 150 km from Milos proves not only the early navigation in Mediterranean Sea but the existence of Man during that period as well.

PERLES (1979) mentions that opsidiane should have been found in this locality quite earlier as the bed which is overlain by small quantities of opsidiane has been dated by the method of C14, 10880 ± 160 years B.C. The origin of opsidiane from Milos is certain.

The study of paleogeographic data of the islands and of the eastern coasts of Peloponnese during the Middle-Late Pleistocene showed that the connection which existed between Milos and Peloponnese during Late Pliocene-Early Pleistocene ceased in the Middle Pleistocene. This means that a possible communication way of the Paleolithic Man is through a discontinued island bridge either from the Laureontic peninsula towards the islands Andros, Naxos and Milos or from Argolis towards the Falconera landmass and Milos island (DERMITZAKIS, 1994). According to this, travellers of the Paleolithic period had to cross the sea-corridors between the islands next to the island bridge. In these corridors primitive rafts or primitive floating means were navigating all the time.

We should conclude therefore that the discovery of opsidiane in Milos was accidental and it was due to a well known kind of travelling and exploring among the islands. However, there is not any archaeological evidence for this.

Sardinia

Sardinia was formed by plate-tectonic splitting and drift, some 30 million years ago.

The Pleistocene mammalian fauna of Sardinia is endemic and consists of only a few taxa, indicating island conditions at the time.

The case of Sardinia is more complicated. The evolutionary trend of mammals does not fit the evolutionary models of other islands where large carnivores are absent (SONDAAR, 1977). In comparison to other island faunas in the Mediterranean, the unbalanced fauna of Sardinia is exceptional. The deer is not at all small, and it does not show a low gear locomotion. Further, the fauna contains the endemic canid *Cynotherium sardous*. It is logical to project that this Pleistocene endemic dog was responsible for the difference in the accepted normal evolutionary pattern.

Within the Pleistocene of Sardinia two faunas can be distinguished (KOTSAKIS, 1981):

1. a younger *Tyrrhenicola* fauna with *Megaceros cazioti*, *Prolagus sardus* and *Tyrrhenicola henseli*.
2. and an older one, the *Nesogoral* fauna with *Nesogoral melonii*, *Rhagamys minor* and *Prolagus figaro*.

Stone artefacts of Lower Paleolithic appearance and traces of working on the bones of fossil deer point to paleolithic human occupation. The stratigraphic situation of some of the finds seems to place them in the Middle Pleistocene, which would make *Homo erectus* the first human inhabitant of Sardinia (ARCA *et al.*, 1982a, b). There are no further traces of human presence on the island until the arrival of *Homo s. sapiens* in the late Upper Pleistocene.

SPOOR & SONDAAR (1986) also found human bones exhibiting beginning endemisation in Corbeddu Cave. The bones come from a stratum radiocarbon-dated 8750 ± 150 BP, which would archaeologically place them in the Mesolithic period.

Based on taphonomical data of animal bones from lower strata, Sondaar places the date of human presence to 14600 BP.

III. SURVIVAL AND ADAPTATION OF THE PLEISTOCENE MAN ON ISLANDS

All Mediterranean islands were invaded by man prior to the Neolithic. The islands which were directly visible from the mainland were certainly visited very early, those which appeared on the horizon during a voyage, but before the continent or another island passed out of sight, probably later. The former case applies to, for instance, Corso-Sardinia, the latter to Crete or Malta.

The disappearance of Pleistocene mammalian faunas on islands can be used to calculate the dates of unrecorded human invasions.

The disappearance of insular faunas when they are brought into contact with continental faunas is a normal phenomenon: the more competitive forms displace the highly specialized insular forms, from their niches.

Man's role in the extinction of most large and mega-herbivores in the Pleistocene is readily explained by the same parameter: The edible fauna disappeared.

The more easterly Mediterranean islands were settled by dwarf elephants and hippos. The dwarfed deer with its low gear locomotion on an island like Crete, must have been easy prey for early man, and hence any potential food stock must have been exhausted rather fast. Furthermore, such animals as the murids, although coexisting with other mammals, were too small to be of interest to Paleolithic man as a potential meat source.

Before the introduction of domestication and agriculture, hunters had little chances of survival once the endemic fauna was depleted.

On the other islands where Paleolithic man was living, like Flores, Timor, Sulawesi and Philippine islands, giant rats would have offered the main food sources. *Prolagus sardus* seems to have acted as such a food source for the Paleolithic inhabitants of Sardinia. From the fossil record it appears that huge quantities of the ochotonid *Prolagus* lived on Sardinia and Corsica during the Pleistocene. They were a major and constant source of food for Paleolithic Man. Deer might have been hunted more occasionally, for gathering food, and also for making tools. Sardinia, with *Prolagus*, must have been suitable for paleolithic settlements during the whole Pleistocene. In both *Nesogoral* and *Tyrrenicola* faunas, *Prolagus* was present in abundance. So it seems likely that the possible downfall of any Paleolithic culture on Sardinia would have taken place with the arrival of Neolithic man.

On the rest of the Mediterranean islands, where the extinction of the most of the endemic fauna took place during the Pleistocene or earliest Holocene, there is little unequivocal evidence for the coexistence of man and Pleistocene fauna.

The first requirement for a Paleolithic settlement on an island is a continuously sufficient stock of food for a hunter-gatherer population. If we accept that the Paleolithic Man was highly dependent on sufficient meat supply, then the faunal composition of the Mediterranean islands must be the reason that most of the islands do not show the prolonged settlement of hunter-gatherer groups.

Many Pleistocene islands in the Mediterranean did not have animals sufficient in size and quantity to offer permanent food for a hunter-gatherer population. The dwarf elephant, deer and hippo must have been an easy prey for paleolithic Man. The rate of reproduction of these mammals is low, and in case of hunting the population must have been reduced or exterminated quickly. So, no ecological equilibrium could be established, and continuous human settlement was not possible.

Small rodents with a high reproduction rate were present on most of the islands, but they likely were too small to allow the gathering of sufficient proteins by a hunting population.

Islands are suitable for permanent colonization by Pleistocene Man only, if exploitation of the natural resources on the island can support a viable human population over a larger period of time, without exhaustion of the resources. On islands with an endemic and unbalanced fauna with a low diversity, the presence of a mammal, large enough in size, with a high rate of reproduction seems to be essential for the permanent settlement of a hunter-gatherer population.

The discovery of obsidian, derived from the Cycladic island of Milos, in the Frahthi cave in the Argolid of the mainland of Greece, dated as Upper Pleistocene, indicates that Paleolithic Man must have had sufficient boat technology for overseas travel (CHERRY, 1981, PERLES, 1979). The geological structure of the island of Milos is a good explanation why there was never a real colonization in this island. The small size of the island and the type of its soils on one hand, and the fear of Paleolithic Man for the volcanic activity on the other hand may be the two possible reasons. Therefore, it is concluded that the trips to Milos were periodical and short enough to collect obsidiane as a secondary work for the search of new sea resources.

Islands with Paleolithic settlements outside the Mediterranean are Flores, Timor, Sulawesi and the Philippines. On these islands giant rats were and are present. Still now, they are eaten by the people on these islands, and they must also have been an important source of food for Paleolithic Man there.

ABSTRACT

The islands of the Mediterranean are well known for their unbalanced endemic Pleistocene mammalian faunal structures. Paleocological conditions on islands have led to the development of faunas with dwarfed species, showing a low gear locomotion due to lack of large carnivores. In this aspect, the younger Pleistocene fauna in Sardinia is different.

On islands with an endemic and unbalanced fauna with a low diversity, the presence of a mammal, large enough in size, with a high rate of reproduction seems to be essential for the permanent settlement of a hunter-gatherer population. The ochotonid *Prolagus* of Pleistocene Sardinia/Corsica fulfilled this requirement. The size of Sardinia/Corsica, and its position not too far from the mainland, made it the only island in the Mediterranean suitable for permanent colonization of Paleolithic Man.

ΠΕΡΙΛΗΨΗ

Ο αποικισμός των νησιών από τον Άνθρωπο έλαβε χώρα σχετικά πρόσφατα, κατά την Νεολιθική περίοδο. Σε ορισμένες όμως περιπτώσεις η μετανάστευση των Ανθρωπίδων πρέπει να έλαβε χώρα νωρίτερα.

Απαραίτητη προϋπόθεση για τον αποικισμό των νησιών από τον Άνθρωπο ήταν η ύπαρξη ανεξάντλητων φυσικών πόρων. Ο Άνθρωπος είχε ανάγκη διατροφής πλούσιας σε ζωικές πρωτεΐνες, γεγονός που απαιτεί μια ισορροπία μεταξύ της τοπικής νησιωτικής πανίδας και του Ανθρώπου. Οι ενδημικές νησιωτικές πανίδες με χαμηλή ποικιλότητα, η παρουσία θηλαστικών μεγάλων σχετικά σε μέγεθος και με υψηλό ρυθμό αναπαραγωγής, έπαιξε ουσιαστικό ρόλο στην πετυχημένη εγκατάσταση του Ανθρώπου.

Στα νησιά του Πλειστοκαίνου, όπου η πανίδα δεν περιλάμβανε σαρκοφάγα ζώα, το μέγεθος έχασε την σημασία του. Το μικρό μέγεθος θα μπορούσε να ήταν και πλεονέκτημα για τους εξής λόγους: λιγότερη αναγκαία ημερήσια ποσότητα τροφής, μεγαλύτερη ευκινησία και μείωση της ζωτικής περιοχής κάθε ζώου.

Οι αλλαγές που υπέστησαν τα θηλαστικά των νησιών μπορούν να εξηγηθούν ως μια προσαρμογή προς το περιβάλλον των νησιών.

Στη Μεσόγειο τα πλέον αποδεκτά μέχρι σήμερα παραδείγματα αποικισμού νησιών αποτελούν η Κύπρος και η Σαρδηνία. Η Κύπρος όπως και η Κρήτη, αποικήθηκαν από τον Νεολιθικό Άνθρωπο ο οποίος έφερε τα κοπάδια, την γεωργία και την αγγειοπλαστική και άλλαξε δραστικά τη ζωή των νησιών. Για τα νησιά αυτά υπάρχουν ακόμη λογικές αμφιβολίες για τον χρόνο εγκαταστάσεως του παλαιολιθικού ανθρώπου. Αντίθετα για την Σαρδηνία τα στοιχεία συνηγορούν υπέρ την αποδοχής της πρόωμης εγκαταστάσεως του Ανθρώπου. Αντίθετα, στην Μήλο δεν έχουμε ανακαλύψει, τουλάχιστον μέχρι σήμερα, ενδείξεις εποίκισης και εγκατάστασης ανθρώπων. Ίσως αυτό να οφείλεται στις ηφαιστειακές ατμίδες που παρέμειναν εν δράσει στο νησί και στη γύρω περιοχή.

REFERENCES

- ADAMS, S.N. (1975). Sheep and cattle grazing in forests. *J. appl. Ecol.*, 12, 143-152.
- AMBROSETTI, P. (1972). L'elefante fossile della Sardegna. *Bol. Soc. Geol. Italia*, 91, 127-131.
- ARCA, M., MARTINI, F., PITZALIS, G., TUVIERI, C. & A. ULZEGA (1982). Il deposito quaternario con industria del Paleolitico inferiore di Sa pedrosa-Pantallinu (Sassari).

- Riv. Sc. Preist.*, 37, 31-53.
- AZZAROLI, A. (1979). Critical remarks on some Giant Deer (genus *Megaceros* OWEN) from the Pleistocene of Europe. *Palaeontogr. Italica*, 71, 1-16.
- AZZAROLI, A. (1981). Cainozoic mammals and the biogeography of the island of Sardinia, Eastern Mediterranean. *Pal.Pal. Pal.*, 36, 107-111.
- AZZAROLI, A. (1982). Insularity and its effects on terrestrial vertebrates. In: Gallitelli E.M. & S.T.E.M. Mucchi (Eds), "*Paleontology, essentials of Historical Geology*". Modena (Italy), 193-213.
- BARNES, R.F.W. (1983). The elephant problem in Ruaha National Park, Tanzania. *Biol. Conserv.*, 26, 127-148.
- BATE, D. (1906). The pygmy *Hippopotamus* of Cyprus. *Geol. Magazine, Dec. V.*, 3, 241-245.
- BOEKSCHOTEN, G.J. & P.Y. SONDAAR (1966). The Pleistocene of the Katharo Basin (Crete) and its Hippopotamus. *Bijdragen tot de Diekunde*, 36, 17-44.
- BURGIO *et al.* (1988). Biostratigraphy of Pleistocene vertebrate faunas of Sicily. *International Conference Early Man in island environments Oliena 1988, Abstracts* (ed. by M. Sanges), p. 61, Martini, Nuoro.
- CHERRY, J.F. (1981). Pattern and process in the earliest colonization of the Mediterranean islands. *Proc. Prehist. Soc.*, 47, 41-68.
- DERMITZAKIS, M.D. (1990). Paleogeography, Geodynamics, Processes and event Stratigraphy during Late Cenozoic of the Aegean area. *Intern. Symposium on "Biogeographical aspects of Insularity", Rome, 18-22 May, Accademia Nazionale dei Lincei*, vol. 85, 263-288, Rome.
- DERMITZAKIS, M.D. (1994). Possible communication during the Paleolithic period in the Saronic and Myrtoon sea based on Geological evidence. *Proceedings of the First International Conference "The Paleolithic of Greece and the Adjacent Areas", I.CO.PA.G., Jannena, September 7-11, 1994*
- DERMITZAKIS, M.D. & J. DE VOS (1987). Faunal succession and evolution of Mammals in Crete during the Pleistocene. *Jahrbuch fur Geologie und Palaeontologie Abhandkung*, vol. 173, 377-408, Stuttgart.
- DERMITZAKIS, M.D. & P.Y. SONDAAR (1978). The importance of fossil mammals in reconstruction paleogeography with special reference to the Pleistocene Aegean Archipelago. *Ann. Geol. des Pays Hell.*, 29, 808-840, Athens.
- DIAMOND, J.M. (1987). How do flightless mammals colonize oceanic islands? *Nature*, 327, 374.
- ESSA, D. & T. KOTSAKIS (1988). Remarks on Cenozoic continental vertebrates and molluscs of Sardinia. *International Conference Early Man in island environments Oliena 1988, Abstracts* (ed. by M. Sanges), p. 59, Martini, Nuoro.
- FACCHINI, F. & G. GIUSBERTI (1987). Restes de *Homo sapiens sapiens* provenant de l' ile de Crete. *Resumes des communications de 2eme Congres International de Paleontologie Humaine, Turin (Italie), 28 Septembre-3 Octobre 1987*, 262-263.
- FRADRICH, H. (1968). Das Flusspferd. *Grzimeks Tierleben: Saugetiere 4* (ed. by B. Grzimek), p. 120-141, Kindler, Zurich.
- GOTELLI, N.J. & G.R. GRAVES (1990). Body size and the occurrence of avian species on land-bridge islands. *J. Biogeogr.*, 17, 315-325.
- GUENTHER, E.W. (1988). Auf Mittelmeerinseln wahrend des Pleistozans lebende Sauger und ihre morphologischen Abanderungen. *Schr. Naturwiss. Ver. Schleswig-Holstein*, 57, 91-108.
- HIGGS A.J. (1981). On island biogeography theory and nature reserve design. *J. Biogeogr.*, 8, 117-124.

- HOREGGER, R.E. (1966). Beobachtungen an eingeführten Säugetieren auf den Galapagos. *Natur u Museum*, 96, 20-27.
- HOOIJER, D.A. (1967a). Pleistocene vertebrates on the Netherland Antilles. In «*Pleistocene extinctions*» (ed. by P.S. Martin and H.E. Wright), p. 399-407. *Yale University Press*, New Haven.
- HOOIJER, D.A. (1967b). Indo-australian insular elephants. *Genetica*, 38, 143-162.
- HOOIJER, D.A. (1975). Quaternary mammals west and east of Wallace's line. *Netherlands J. Zool.*, 25(1), 3, 46-56.
- JACOBSCHAGEN, V. (1986). Geologie von Griechenland. *Borntraeger*, Berlin.
- KEEGAN, W.F. & J.M. DIAMOND (1987). Colonization of islands by humans: a biogeographical perspective. *Adv. Archeol. Method. Theory*, 10, 49-92.
- KORTLANDT, A. (1976). Tree destruction by elephants in Tsavo National Park and the role of man in African ecosystems. *Netherl. J. Zool.*, 26, 449-451.
- KOTSAKIS, T. (1981). Osservazioni sui vertebrati quaternari della Sardegna. *Bol. Soc. Geol. Ital.*, Roma, 99, 151-165.
- KUSS, S.E. (1973). Die pleistozanen Säugetierfaunen der ostmediterranen Inseln-Ihr Alter und ihr Herkunft. *Ber. Naturf. Ges. Freiburg Br.*, 63, 49-71.
- KUSS, S.E. (1975). Die pleistozanen Hirsche der ostmediterranen Inseln Kreta, Kasos, Karpathos und Rhodos (Griechenland). *Ber. Naturf. Ges. Freiburg Br.*, 65, 25-79.
- LAX, E.M. (1996). A Gazetteer of Cretan Paleontological Localities. In: D.S. Reese (Ed), «*Pleistocene and Holocene Fauna of Crete and its first Settlers*», *Monographs in Worlds Archaeology*, No 28, 1-32.
- LEINDERS, J.J.M. & P.Y. SONDAAR (1974). On functional fusions in footbones of Ungulates. *Z.f.Säugetierkunde*, Hamburg, 39, 109-115.
- MADE VAN DER J. (1996). Pre-Pleistocene Land Mammals from Crete. In: D.S. Reese (Ed), «*Pleistocene and Holocene Fauna of Crete and its first Settlers*», *Monographs in Worlds Archaeology*, No 28, 69-80.
- MAYHEW, D.F. (1996). The Muricids. In: D.S. Reese (Ed), «*Pleistocene and Holocene Fauna of Crete and its first Settlers*», *Monographs in Worlds Archaeology*, No 28, 167-172.
- MCARTHUR, R.H. & E.O. WILSON (1967). The theory of island biogeography. *Princeton University Press*, Princeton.
- MENCHING, H.G. (1990). Desertifikation, ein weltweites Problem der ökologischen Verwüstung in den Trockengebieten der Erde. *Wissensch. Buchges.*, Darmstadt.
- MULLER-DOMBOIS, D. (1989). Crown distortion and elephant distribution in the woody vegetation of Ruhunu National Park, Ceylon. *Ecology*, 53, 208-226.
- OTTICHILO, W.K. (1987). The causes of the recent heavy elephant mortality in the Tsavo ecosystem, Kenya, 1975-80. *Biol. Conserv.*, 41, 279-289.
- PERLES, C. (1979). Des navigateurs méditerranéens il y a 10.000 ans. *La recherche*, 10, 82-83.
- REESE, D. (1975). Dwarfed Hippos: past and present. *Earth Science*, 28, 63-69.
- REUMER, J.W.F. (1996). Shrews (Soricidae) on islands, with special reference to *Crocidura zimmermanni* from Crete. In: D.S. Reese (Ed), «*Pleistocene and Holocene Fauna of Crete and its first Settlers*», *Monographs in Worlds Archaeology*, No 28, 173-180.
- SIMBERLOFF, D.S. (1974). Equilibrium theory of island biogeography and ecology. *Ann. Rev. Ecol. Syst.*, 5, 161-182.
- SIMMONELLI, V. (1897). Candia-Ricordi di escursione. *Parma*, Battei.
- SIMMONS, A.H. (1988a). Pygmy Hippos, early man and the initial Human Occupation of Cyprus. *International Conference «Early man in island environments» Oliena 1988*, Abstracts (ed. by M. Sanges), p. 80, Martini, Nuoro.
- SIMMONS, A.H. (1988b). Test excavations at Akrotiri-Aetokremnos (site E), an early

- Prehistoric occupation in Cyprus: preliminary report. *Report Dep. Antiquit. Cyprus*, 1988, 15-24.
- SMART, N.O.E., HATTON, J.G. & D.H.N. SPENSE (1985). The effect of long-term exclusion of large herbivores on vegetation in Murchison Falls National Park, Uganda. *Biol. Conserv.*, 33, 229-245.
- SONDAAR, P.Y. (1977). Insularity and its effect on Mammal Evolution. In: Hecht *et al.*, (Eds): *Major Patterns in Vertebrate Evolution*, New York, 671-707.
- SONDAAR, P.Y. (1981). The *Geochelone* faunas of the Indonesian Archipelago and their paleogeographical and biostratigraphical significance. *Modern Quatern. Res. in SE Asia*, 6, 111-120.
- SONDAAR, P.Y. & G.J. BOEKSCHOTEN (1967). Quaternary mammals in the south Aegean island arc with note, on other fossil mammals from the coastal regions of the Mediterranean. *I,II, Proc. Kon. Nederl. Akad. Wetensch*, B, 7, 556-576, Amsterdam.
- SONDAAR, P.Y., DE VOS, J. & M.D. DERMITZAKIS (1996). The Paleogeography and Faunal Evolution of the Land Mammals of Crete. In: D.S. Reese (Ed), "*Pleistocene and Holocene Fauna of Crete and its first Settlers*", *Monographs in Worlds Archaeology*, No 28, 61-68.
- SPOOR, C.F. & P.Y. SONDAAR (1986). Human fossils from the endemic island fauna of Sardinia. *J. Human Evol.*, 15, 399-408.
- STRID, A. (1971). Evolution in the Aegean. *Opera Botanica*, 30, Gleerup, Lund.
- SWINY, S. (1988). The Pleistocene fauna of Cyprus and recent discoveries on the Akrotiri peninsula. *Report Dep. Antiquit. Cyprus*, 1988, 1-14.
- VOS, DE, J. (1996). Taxonomy, Ancestry, and Speciation of the Endemic Pleistocene Deer of Crete compared with the Taxonomy, Ancestry and Speciation of Darwin's Finches. In: D.S. Reese (Ed), "*Pleistocene and Holocene Fauna of Crete and its first Settlers*", *Monographs in Worlds Archaeology*, No 28, 111-124.
- WILLEMSEN, G.F. (1996). The Cretan Otter *Lutrogale cretensis*. In: D.S. Reese (Ed), "*Pleistocene and Holocene Fauna of Crete and its first Settlers*", *Monographs in Worlds Archaeology*, No 28, 153-158.