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CRETE BEFORE THE CRETANS: THE REIGN OF DWARFS

Alexandra van der Geer, Michael Dermitzakis and John de Vos

Introduction

When archaeologists speak of prehistory, they have epochs in mind as bronze age, stone age. In other words, epochs that are revealed to us by means of artefacts, left overs of a human culture. The word prehistory validates this idea, as indeed those epochs are from before the emergence of written or pictographical sources, in short, what we call 'history'. However, this is only a very small part of the chronological truth: the world did of course not start with the human culture. There is far more prehistory than history, and major part lies well before the archaeological pre-history. This is the domain of the palaeontology, where geological epochs are revealed by means of fossils in the broad sense.[1]

The island of Crete as we know, yielded a vast amount of cultural remains, among which those of the Minoan culture became world famous. But Crete also appeared to be a treasure box of much older remains, and 63 localities with fossils have been reported.[2] From the 1970's on, Dutch researchers (University of Utrecht) started excavations on Crete, in close collaboration with the University of Athens.[3] Based upon the hitherto described fossils, the pre-prehistory of Crete and its early inhabitants can be reconstructed. In this article, we focus on that part of Cretan's history between the time of its emergence and the arrival of the first humans on the island.

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[1] Fossils include not only petrified left overs of an animal body, mainly structural parts like the skeleton, dentition, shells but also (imprints of) soft tissues like the brain or a complete body of a mollusc. Other traces of past life consists of conserved imprints of the animal or its trail.

[2] Dermitzakis 1977; Lax 1996. The first fossils were collected and described as early as 1745 by Pococke (1745, II: 264), who discovered a fossiliferous cave in the region of the Akrotiri of Chania. Other early explorations were those of Spratt (1865), Raulin (1869), Simonelli (1894, 1907, 1908) and Bate (1905, 1912, 1942).

[3] See for this collaboration the website of the Netherlands Institute in Athens, section paleontology.

Crete, an "oceanic-like island"

Crete was not always an island. Upto the Vallesian period of the Late Miocene (9,0 Ma ago)[4], Crete was connected to the mainland of Asia Minor, as shown by fossil remains of mainland fauna.[5] It were the times when, in this chronological order, dorcatheres, crocodiles, three-toed horses and early deer roamed the region.[6]

Gradually, Crete got fragmentated into small pieces during the late Early Miocene (9-5,3 Ma ago) and Early Pliocene (5,3-3,6 Ma ago) and became submerged largely towards the end of that period, known as the Pliocene transgression, which started in West Crete and proceeded towards the East including Rhodes.[7] As a result, marine deposits and late Tortonian (8-7 Ma ago) foraminifera beds overlay the remains of the older fauna of the Miocene.[8] Later, the region emerged again, and finally, at the end of the Pliocene or in the Early Pleistocene, Crete got its present configuration.[9]

Islands that freshly arise from the sea or ocean, and not by the disappearance of a land-bridge that connects them to the mainland, are called oceanic islands.[10] The definition is extended to islands that were once in their remote history connected to the mainland, got submerged, and arose again by sea-level changes; they are called oceanic-like islands;[11] Crete is such a case.

The new and virgin island of Crete became gradually colonized by animals, which arrived there by swimming, drifting or flying,[12] which is typical for oceanic and oceanic-like islands. Once on the island, the fauna slowly changed and evolved into a characteristic endemic island fauna, restricted to the island of Crete. This is a normal process, which is observed on many other oceanic and oceanic-like islands as well. [13] On these islands dwarf elephants[14], dwarf deer[15], dwarf hippo's[16], and dwarf goats[17] occurred. Apart from the dwarfism of the megafauna, a simultaneous gigantism may be observed of the microfauna[18] and of birds of prey[19]; a clear example is that of the simultaneous occurrence of a giant hamster and a giant murid with a giant eagle and giant owl on Italy's Monte Gargano.[20]

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4 Following the geochronology of Berggren *et al*. 1995.

5 Van der Made 1996.

6 *Dorcatherium* (Melambes), crocodiles (Plakia), *Hipparion* (older sites on Kastellios Hill), cf. *Pliocervus* (younger sites on Kastellios Hill).

7 Sondaar, De Vos & Dermitzakis 1986 and Sondaar, Dermitzakis & De Vos 1996.

8 De Bruijn *et al*. 1971, Sondaar, De Vos & Dermitzakis 1986, Benda, Meulenkamp & Zachariasse 1974 and Sondaar, Dermitzakis & De Vos 1996.

9 Sondaar, De Vos & Dermitzakis 1986.

10 Darlington 1957. Examples are vulcanic islands like Thira (Santorini) and land masses on an uplifting block.

11 Alcover, Sans & Palmer 1998.

12 Sondaar & Boekschoten 1967 and Dermitzakis & Sondaar 1978.

13 Sondaar & Dermitzakis 1982 and Sondaar & Van der Geer 2005.

14 Cyprus, Crete, Tilos, Delos, Kithnos, Milos, Naxos, Serifos, Rhodos.

15 Crete, Kasos, Karpathos, Ryukyu islands of Japan, Monte Gargano of Italy.

16 Crete, Cyprus.

17 Mallorca, Menorca.

18 Size increase in island micromammals is reported for e.g. *Canariomys* from the Canary Islands (Crusafont-Pairo & Petter 1964), *Kritimys* from Crete (Mayhew 1977), *Eliomys* from the Balearics (Reumer 1994), *Deinogalerix* from Gargano (Freudenthal 1972), *Hattomys* from Gargano (Freudenthal 1985).

19 Sondaar 1977.

20 Freudenthal 1971.

Much later, during the Holocene, aceramic neolithic humans came by rafts or boats to islands like Crete and settled there. This probably caused a dramatic end to the local fauna, not only because of hunting, but also because of the herbivores such as cattle, pigs, and later also fallow deer, red deer and horses and because of the hitch-hiking rodent and lagomorph guests that came along with them. With the arrival of humans, we enter the domain of archaeology and leave that of palaeontology.

Candidates for colonization

The new Pleistocene island of Crete was not colonized by all vertebrate groups. From the fossil record it appears that the successful colonizers were hippopotamids, elephants, deer, otters, rodents and birds. Not a single trace has been found of other ungulates, like horse, pigs, bovids, nor of carnivores others than an otter. Such an indiscrepancy in fauna composition is known as an unbalanced fauna, which is typical for oceanic and oceanic-like islands.[21] This type of island is not and was never connected to the mainland by a land bridge, and can thus only be reached by air, by swimming or by hitchhiking on floating objects.[22] The only animals that are reported to be capable of such open sea transport are hippopotamus, elephants, deer, otters, rodents[23] and shrews[24]; and it are these animals that are found in fossil island faunas. If the island is close to the mainland, the colonizers stay in contact with their parent population by returning themselves or by periodically new arrivals. If the island is more isolated, either geographically either by strong currents, the return may be impossible, and they are forced to settle on the island. Such a dispersal, meaning that the geographical route is impossible for most species and possible only on rare occasions for others, is known as sweepstakes dispersal.[25] To be a candidate for successful colonization, the species should further not live a solitary life, but prosper in herds or groups; otherwise its change on meeting a mate is near to zero. Medium-sized or large carnivores are lacking by definition, because even if they are not solitary, they won't find enough prey to sustain.

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[21] Sondaar 1977.

[22] The candidates for colonisation of the other type of island, which got disconnected from the mainland either through submerging of the in-between land mass or a sea-level rise, are essentially different. They are already present on the island, and there is no need to swim, fly or hitchhike. The only problem they have, which is severe enough, is to survive on a increasingly limited area. Carnivores, especially the large ones, meet the largest problems, but also the herbivores will feel the need to reduce their dietary income, and as a consequence, reduce their body size. On those islands, we see an impoverished mainland fauna with in many case a reduction in body size of about 20 percent. Examples are Kerkyra (Corfu), Kefallina, Chios.

[23] Hippopotamuses swim from Africa to Zanzibar (Joleaud, 1920) and to Madagascar (Mahe, 1972). Elephants swim off-coast in the Bay of Bengal (Carrington 1962). Deer are well-known for their excellent swimming capacity (Nowak 1999: 1092). Otters live by definition an aquatic or semi-aquatic life. Rodents are good swimmers, but can also hitchhike like shrews.

[24] Shrews are very delicate creatures, as they can survive no more than a few hours without food. This is because of their extremely small body size, which requires a high metabolic rate. As a result, if shrews would swim or float to an island, they can only venture a travel of a few hours. Rafting on larger parts of floating vegetation, as have been reported to flow into the open sea from river mouths, is the only way the shrew *Crocidura* could have reached the island of Crete.

[25] *sensu* Simpson 1965.

Colonization of Crete

Remarkably enough, the island of Crete was invaded twice during the Pleistocene. At first, from the Early till the late Middle Pleistocene, it was mainly inhabited by a dwarf hippopotamus, a dwarf mammoth and a large mouse. Afterwards, from the late Middle Pleisocene till the arrival of humans in the Holocene, it was mainly occupied by a small elephant, five sizes of deer and a normal sized mouse. The reason for the dramatic faunal turn-over at the Middle Pleistocene on Crete can be only guessed at, but a relation with global eustatic sea-level fluctuations is likely, inasfar there is a major lowering of the sea-level starting at 0,8 Ma ago,[26] increasing in this way the accessibility of many islands. The sweepstake arrival of newcomers could result in extinction of the earlier inhabitants. The cause of the next faunal turnover, which lead to the extinction of the endemic deer, may simply have been the arrival of paleolithic humans. They could have exterminated the deer either actively by hunting, or passively by destroying its habitat. Another option is a gradual depletion of the eco-system, as indicated by the finding of a complete herd consisting of individuals suffering a bone disease of a osteosclerotic nature.[27] The impact of paleolithic humans is at present still unproven, partly because of the scarcity on published fauna lists from archaeological sites (except for Knossos), partly because of the insecurely dated materials.[28]

Pleistocene biozones of Crete

Excavations in the many cave localities[29] revealed a clear zonation in the Pleistocene fossil record. In total two main bio-zones consisting of respectively three and two subzones, based on the murid species.[30] This means that there is one major faunal turnover during the Pleistocene. The disappearance in the faunal record of the Cretan dwarf mammoth and the dwarf hippopotamus and the appearance of the Cretan deer and the dwarf elephant characterize this turnover. At the same time, the endemic Cretan mouse is replaced by the common mouse. The faunal assemblages can be summarized as follows.

Biozone one (Early and early Middle Pleistocene = 1,8 Ma - 0,3 Ma): the Kritimys Zone[31].

Typical fauna elements of this biozone are the Cretan mouse (*Kritimys* aff. *kiridus*, *Kritimys kiridus* and *K. catreus*), the soricid (*Crocidura zimmermanni*), the Cretan dwarf mammoth (*Mammuthus creticus*) and Creutzburg's dwarf hippo (*Hippopotamus creutzburgi*).

[26] Haq, Hardenbol & Vail 1987 and Haq 1991.
[27] Braber 1981 and Dermitzakis, Van der Geer & Lyras 2006.
[28] Jarman 1996.
[29] For an overview of all paleontological sites, see Lax 1996.
[30] Mayhew 1996. The five assigned murid species belong to two genera, the larger Cretan mouse *Kritimys* and the smaller mouse *Mus*. The genus *Kritimys* is strictly restricted to Crete, whereas the originally Indian genus *Mus* had already a wide Eurasian distribution by that time.
[31] *sensu* De Vos 1984.

The Cretan mouse is represented by three species, forming a lineage. The species *K. kiridus* is older than *K. catreus*, which latter is also much larger, even larger than a brown rat (*Rattus norvegicus*); the earliest and smallest species of the lineage is *K*. aff. *kiridus* from Siteia.[32] The different *Kritimys* species are not found together.

The earliest finding of the dwarf hippo is at Siteia I,[33] where it occurs together with the earliest form of the Cretan mouse.[34] In younger localities, the dwarf hippo is found together with the intermediate form of the Cretan mouse, but never with the giant form.[35] The most famous dwarf hippo locality is the Katharo basin near the village Kritsa in the Dikti mountains (plate Ia-b). This basin is at a height of 1100 m above the sea, which is not exactly a place where you expect to find hippos. The dwarf hippo was not only very small in size (plate II), but walked also more on its hooves instead of on its footpad, compared to its mainland ancestor *H. antiquus*.[36] This is explained as adaptation to a less aquatic life in a more rocky environment,[37] which seems to fit with the environment of the Katharo.

The earliest finding of the dwarf mammoth is from Akrotiri Melekas 1.[38] The youngest association of dwarf mammoth with dwarf hippo is Katharo 1 (around 400.000 years BP).[39] The dwarf mammoth is really a pygmy form compared to mainland mammoths[40] and has a shoulder height of only 1.5 m.[41] Its limbs are very short in relation to body length, when compared with living elephants.[42] It has been suggested that its sturdy and solid limbs, together with a possible higher degree of bone fusions (synostosis), indicates an adaptation to a more uneven and rugged terrain.[43]

Biozone two (late Middle and Late Pleistocene = 0,3 Ma - 0,01 Ma): the Mus Zone.[44]

The typical fauna elements of this biozone are the common mouse (*Mus bateae, M. minotaurus*), the dwarf elephant (*Elephas antiquus creutzburgi*), the Cretan deer (*Candiacervus*, with the eight species *ropalophorus*, sp. IIa, b and c, *cretensis*, *rethymnensis*, *dorothensis* and *major*), the Cretan otter (*Lutrogale cretensis*), and the Cretan shrew (*Crocidura zimmermanni*)[45].

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[32] It has been suggested that the earliest *Kritimys* (*K*. aff. *kiridus*) is an immigrant from Rhodes, via Kassos and Karpathos, based on a similar finding at the Damatria formation on Rhodes (Mayhew 1977, 1996).
[33] Spaan 1996.
[34] Mayhew 1977, 1996.
[35] Mayhew 1977.
[36] Spaan 1996.
[37] Sondaar 1977 and Spaan 1996.
[38] Mayhew 1977, 1996. Other name for this site is Cape Maleka I. This site is somewhat younger in age than Siteia 1, based upon the evolutionary stage of *Kritimys*.
[39] Datings from Reese, Belluomini & Ikeya 1996.
[40] Its most likely mainland ancestor is the southern mammoth (*Mammuthus meridionalis*), see Mol *et al*. 1996.
[41] De Vos 1984 and Dermitzakis & De Vos 1987.
[42] Ambrosetti 1968.
[43] Sondaar 1971, 1977.
[44] *sensu* De Vos 1984.
[45] The Cretan shrew is part of the second Pleistocene biozone, with the exception of one locality, Xeros, where it occurs together with *Kritimys catreus*, which belongs to the first biozone.

Plate Ia-b. *Excavations at Katharo Plain near the village of Kritsa, community of Agios Nikolaos. The locality is especially famous for its large amount of fossils of the dwarf hippo Hippopotamus creutzburgi.*

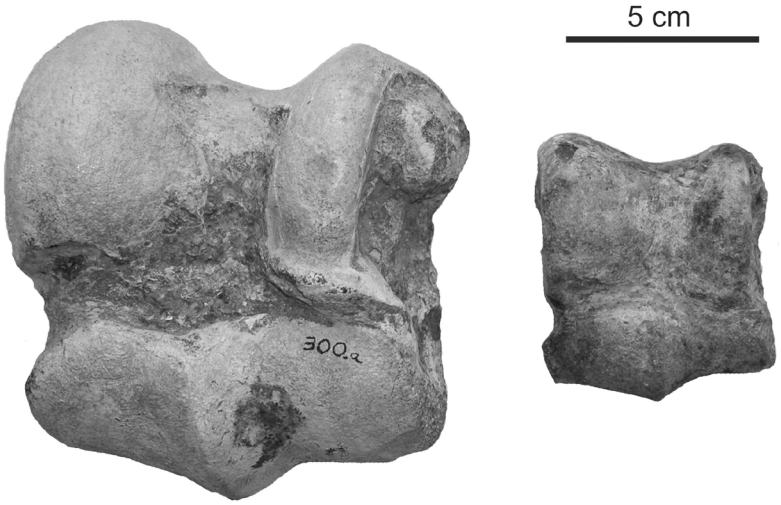

Plate II. *An astragulus (ankle bone) of a mainland hippopotamus (H. antiquus) (to the left) compared to that of the dwarf hippo from Crete (to the right).*

The common mouse is represented by two species, of which the earlier is *M. bateae*, which is slightly smaller than the later *M. minotaurus*, and slightly larger than the common house mouse (*Mus musculus*). The two species belong to a single lineage. Like in the case of the Cretan mouse of the previous biozone, a long term trend for increasing size is attested.

The Cretan shrew is one of the rare exceptions to the general rule that mammals change radically on islands. On most islands, the microfauna show the tendency to become large, as is the case of the Cretan mouse of the previous biozone.[46] It is as yet not clear why this did not apply to

[46] The main difference with the mainland is the absence of mammalian predators, except for the otter, but that is a fish and shellfish eater. Birds of prey are selective towards prey size, and cannot handle larger prey than their usual prey as they have to swallow them as such, whereas mammalian predators simply tear them into smaller pieces. On islands, this is the main advantage to increase size for rodents.

the Cretan shrew.[47] The Cretan shrew was obviously successfull, and was not wiped out during the next faunal turnover, and managed to survive on Crete till the present day[48].

The dwarf elephant may be large compared to the mammoth of the previous period, but it is still about 30% smaller than its mainland ancestor *E. antiquus*, which has a shoulder heigth of 3.7 m.[49] The dwarf elephant has strongly curved tusks. It is still a matter of debate why this elephant did not reach a pygmy size.[50]

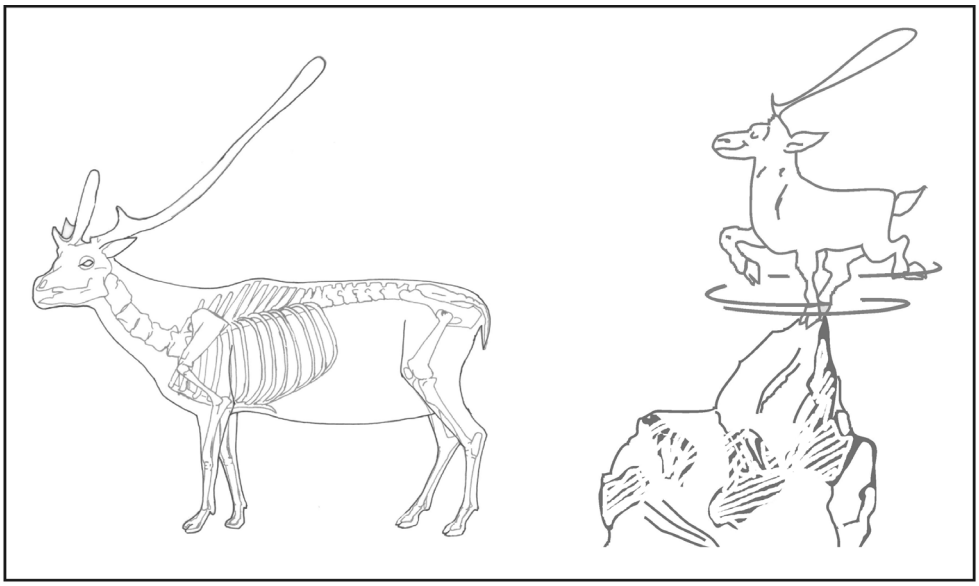

Figure 1. *Left: The two smallest Cretan deer have short limbs, a massive body and long, simplified antlers. Right: Their ecological niche was similar to that of the Cretan wild goat (Capra aegagrus) of today: barren rocks with thorny bushes. (Drawing G. Lyras)*

The earliest find of the Cretan deer is in Charoumbes 2 (not dated); the youngest is Simonelli Cave I (about 21,500 BP).[51] The Cretan deer is represented by no less than eight different morphotypes, ranging from dwarf size with withers height of about 40 cm to very large with withers height of about 165 cm.[52] This is explained as a sympatric speciation to occupy all possible empty

[47] Reumer 1996.

[48] Apart from *C. zimmermanni*, two other shrews live today on Crete (Reumer 1996): *C. suaveolens caneae* introduced around 1700-1550 BC and *Suncus etruscus*, found as early as 1370-1200 BC. The fossil and the living *C. zimmermanni* are the same species (Reumer 1986). There is no genetic relation between *C. zimmermanni* and the later introduced *C. suaveolens* (Vogel 1980). Unfortunately, the Cretan shrew lives today only in two elevated regions of Crete. It is a unique relic species, being the only survivor of a once existing completely different world of endemic species, and deserves therefore active conservation.

[49] Dermitzakis & De Vos 1987.

[50] De Vos 1996 suggests that the simultaneous presence of a wide variety of endemic deer prevented dwarfing.

[51] Belluomini & Delitala 1983.

[52] De Vos 1979, 1996.

niches ranging from dense forest to prickly rocks.[53] The coexistence of various environments has been confirmed by studies on the rich fossil avifauna.[54] The most typical Cretan deer are the two smallest sizes, which have not only relatively and absolutely short limbs, but also long and simplified antlers; these species occupied a niche close to that of the wild goat of Crete today: barren rocks with thorny bushes (fig. 1), as shown by features of their osteology and goat-like body proportions.[55] It deviated so much from mainland deer that it is impossible to indicate with certainty its ancestor (plate IIIa).[56] The Cretan deer is a typical example of taxonomical problems involving endemic insular mammals, due to the much larger variety than on the mainland, and the strong endemism, wich obscures taxonomy.[57]

Plate IIIa. *The Cretan deer Candiacervus (below, right) differs greatly from mainland deer (left), here represented by one of its suggested relatives, Megaloceros giganteus.*

Plate IIIb. *Skeleton of the Cretan otter Lutrogale cretensis.*

[53] De Vos & Van der Geer 2002.

[54] Weesie 1988.

[55] Van der Geer *et al*. 2005.

[56] The most likely earlier suggested candidates are *Cervus peloponnesiacus* and *Megaloceros* (plate IIIa), see De Vos 1996.

[57] De Vos (1979, 1984, 1996) includes the eight morphotypes into one genus (*Candiacervus*), whereas Capasso Barbato (1992) does not follow this opinion of monophyly, and included the larger species, *rethymnensis*, *major* and *dorothensis*, in *Cervus* (subgenus *Leptocervus*) and the smaller species *ropalophorus* and *cretensis* in *Megaloceros* (subgenus *Candiacervus*), which implies two different ancestors. She also does not recognize sp. II with its three morphotypes, and synonymises them with *ropalophorus*. At present these two views cannot be properly proven or discarded, but what stays is that the number of deer species is higher than on the mainland, and that they all occupy a different ecological niche.

The Cretan otter (plate IIIb) is the only carnivore known from the Pleistocene of Crete.[58] Its remains are known from only one locality (Liko Cave), and only in the upper layer thereof (Late Pleistocene). The Cretan otter was less aquatic in life style than the common otter (*Lutra lutra*) and *Lutrogale perspicillata*; this is considered a secondary development due to the special conditions on Crete.[59] At first view it may seem strange that the Cretan otter did not develop towards gigantism as in rodents or towards dwarfism as in herbivores, though it seems that it is slightly larger than its mainland ancestor.[60] However, this gigantism and dwarfism is caused by common factors as the absence of predators and limited food resources; for otters these factors are not relevant.

Conclusion

Crete was completely submerged during the Pliocene, and gradually emerged in the Early Pleistocene. New and empty islands like these are normally colonized overseas by sweepstake dispersal, which means that only a limited number of taxa is able to reach the island. This results in an unbalanced mammal fauna, as a rule consisting of only elephants, hippopotamus, deer, cattle, rodents, insectivores and sometimes otters. After successful colonization, as a rule a fast evolutionary change takes place, which can be explained as an adaptation to the restricted island environment. As a result, island faunas are very different from mainland faunas, but similar to each other. Crete is no exception to this general pattern, and during the Pleistocene there were two successive endemic mammalian faunas. The first (the *Kritimys*-biozone) is characterised by a dwarf mammoth, a dwarf hippopotamus and a giant mouse.[61] The second (the *Mus*-biozone) is characterised by a dwarf elephant, a dwarf deer (next to medium and large sized deer) and a large mouse.[62] The reason for the dramatic faunal turnover between the two biozones is unknown, but may very well have been related to a significant sea-level drop. This decreases the distance between the now larger island and another firm ground. The second fauna got extinct just before or after the arrival of the first humans. Problems of dating and the lack of paleolithic artefacts or human remains obscures this point. In any case the fauna of the second biozone was already completely extinct at Aceramic Neolithic and Minoan times, and replaced by newcomers who came together or along with the humans.

[58] Willemsen 1996; the other fossil carnivores (beech marten and badger) belong to the Holocene.

[59] Willemsen 1980. The most likely ancestor is *Lutrogale perspicillata*, which is at present restricted to Asia, but had a much wider distribution in the past (Willemsen 1980).

[60] Willemsen 1996.

[61] *Mammuthus-Hippopotamus* fauna, age: Early to early Middle Pleistocene, extinction: arrival of mainland taxa by sweepstake dispersal, leading to the next fauna. The fauna of this period is an unbalanced, impoverished endemic fauna.

[62] *Elephas-Candiacervus* fauna, age: late Middle Pleistocene-Holocene, extinction: arrival of mainland taxa, most likely including humans and their cattle and hitchhiking guests. Also the fauna of this period is an unbalanced, impoverished endemic fauna, that was, however, different from the previous period.

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