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Some considerations on the Pleistocenic Elephants of the Mediterranean islands

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Abstract

During the Pleistocene some Mediterranean islands were repeatedly colonized by species of elephants that evolved into endemic dwarf forms. The reason for such dwarfism is to be found among multifacet ecological adaptations. The key to understand the size reduction of the insular Pleistocenic elephants is to consider a plurality of evolutionary *patterns*, including island area, the limited natural resources, absence of genetic flow, the interaction with the other elements of the insular fauna, the type of habitat (niches) and the different geological periods in which the fossils were found.

Keywords: Elephants; islands; Mediterranean; Pleistocene; evolution; isolation; endemism; patterns

Riassunto

Durante il Pleistocene, nelle isole del Mediterraneo, gli elefanti che vi sono giunti attraverso corridoi naturali durante le glaciazioni, sono stati interessati da processi evolutivi endemici, un adattamento morfologico-funzionale alle particolari condizioni ambientali, con riduzione di taglia fino a forme estreme di nanismo. La chiave di lettura per comprendere la riduzione e la diversità di taglia degli elefanti insulari pleistocenici è multifattoriale e quindi occorre considerare una pluralità

di *pattern* evolutivi quali: anzitutto la grandezza dell'isola, le conseguenti limitate risorse naturali, l'accoppiamento fra un numero limitato di individui, l'interazione con i predatori presenti, il tipo di habitat (nicchie) e infine i diversi periodi geologici in cui ricadono i resti fossili ritrovati con la loro ricostruzione biocronostratigrafica.

Parole chiave: Elefanti; isole; Mediterraneo; Pleistocene; evoluzione; isolamento; endemismo; *patterns*

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Introduction

The geographical isolation involves "forced" pairing among a narrow group of individuals and the lack of sexual mixing among the different genetic pools of the separate populations, or rather the absence of genetic flow and therefore of variability: under the push of the environmental pressure some individuals are selected endowed with larger adaptive value. The insular endemic faunas present opposite evolutionary phenomena: the dwarfism (reduction size in comparison to the continental ancestor) that manifests in the larger mammals and the gigantism (the increase in comparison to the continental form of origin) of small mammals and of birds and reptiles. The causes of the insular dwarfism, of which we have numerous examples in Pleistocene, are to be found in the fact that the smaller dimensions allow the mammalian colonizers (who succeed in migrating through the narrow natural corridors) to survive in environments with limited resources (such as the islands), while the insular gigantism (the other form of adaptation) of micromammals and of birds and reptiles is primarily due to the absence of predators, or, however, to an altered food chain: very well known cases are the Moa of the New Zealand and the Monitor Lizard of Komodo. For the assessed insular gigantism in some islands of the Mediterranean represented, for instance, by the giant dormouse *Leithia melitensis* that lived in the middle Pleistocene in Sicily, as well as in Malta, the matter is more complex because there was no complete lack of predators in these environments: in Sicily lived, for instance, *Mustelercta arzilla* a mustelid similar to the pine marten, a well known formidable predator of dormice, which, in theory, could have prevented the appearance of the gigantism. *Mustelercta arzilla* (De Gregorio 1886), shows a lot of affinities with its close relative *Pannonicitis kormos* and *Enhydrictis major,* that lived from the superior Pliocene to the inferior Pleistocene (Burgio & Fiore 1997). In the Mediterranean islands the discovered fossils of the Mustelidae such as *Mustelercta arzilla* or of Felidae such as *Felis silvestris*, natural

predator of the dormice and other rodents, are quite rare: probably this is due not as to their absence in nature, as to the brittleness of their bones that can be more easily lost and breakable, in comparison to those stronger of elephants, hippos and endemic bucks. It is also necessary to say that in Sicily *Leithia melitensis* is found in partnership with the rests of *Leithia cartei* of the same genus but of similar size as the actual dormouse: the geographic ranges were clearly separate however occupying two different ecological niches (Petronio 1970). Probably an immigration of the continental progenitor of *Leithia cartei* occurred when on the island *Leithia melitensis* was already present and differentiated with a process of endemic speciation. A more recent hypothesis to explain the size increase of small mammals on the islands, implies an adaptive modification to render them less vulnerable by the birds of prey: the latter however are also present on the continent even in larger measure, but we don't find cases of gigantism. I believe that the answer has to be found elsewhere. Made this premise, we turn our attention to the insular endemic pleistocene elephants.

A plurality of evolutionary patterns

During the periods of sea level lowering, in correspondence of the glaciations, the islands were colonized many times by elephants coming from the continent, belonging to the kind *Palaeoloxodon antiquus* (5 ms of height at the withers), which, adapting themselves to the insular environmental conditions, reduced size in the time, giving origin to different kinds (or subspecies) of different bodily dimensions, up to extreme forms of dwarfism, as in the case of *Palaeoloxodon falconeri* (90 cm at the withers). Fossils of dwarf elephants have also been discovered in Cyprus, Malta, Crete, Sardinia, Cyclades and Dodecanesian islands. Of course the insular dwarfism in the Mediterranean islands has interested a lot of other kinds of mammalia such as the hippo and the wild boar (Raia & Meiri, 2006). It needs to be said that the procedures of colonization and the migratory routes of the continental faunas can not be referred to one episode: every island in fact exhibits a peculiar geological evolution with specific characteristics. Tectonic activity in concomitance with oscillations of the sea level during the glaciations created some bridges through which the continental fauna could reach the islands with subsequent colonization; small kinds as reptiles and rodents could also have reached the islands on trunks and planking, without considering the flight for the birds and the bugs (Caloi et al., 1996). But how to explain the presence of nearby fossils of elephants of different size on different islands of the Mediterranean besides, if not in different geological layers, the dwarf forms? In Sicily and Malta we find in fact fossils of elephants of average size (*Palaeoloxodon mnaidriensis*, tall around 2 ms at the withers), as long as in Crete we have *Palaeoloxodon creutzburgi*, and other intermediate sizes have been found in Cyprus, in some Dodecanesian islands and in the Cyclades. The size of the elephant of Delos and of Rhodes had dimensions comparable to those of *P. mnaidriensis* (Van der Geer et al., 2004), while on the island of Tilos we find both elephants of dwarf and medium size (*P. tilensis*), but the two groups refer to sexual dimorphism (Theodorou 1983-1988). Also the Sardinian elephant

(*Mammuthus lamarmorae*) shows a middle form descending from the gigantic *Mammuthus meridionalis*.

An advanced hypothesis on the presence of elephants of different size on some islands of the Mediterranean brings back the possible explanation of the different migratory flows of representatives of *P. antiquus* from the continent: the evolutionary attempt of reduction would have occurred a first time (in the medium Pleistocene) to a form of extremely reduced size (*P. falconeri*), while a second time (close to the superior Pleistocene) it would have arrested toward a medium form. One can wonder indeed what is the cause that brings the evolutionary way of reduction toward two forms of different sizes.

To my advise the fossil remains of elephants of reduced size could be explained by a form more or less accented of dwarfism, an adaptation to the different present ecological niches on islands of a certain magnitude and in a determined geological period that the continental elephants in migration occurred to occupy: a first niche is represented by the forest, a habitat in which elephants of small size were able better to hide from the predators (es. dwarf elephant of Borneo) and to find a precious source of nourishment; the second niche corresponds to an environment of more open clearings for an elephant of medium size that, thanks to the most greater massive structure and the fact of living in small groups, was able of a better self defence from the predators chasing in flock, such as wild dogs of

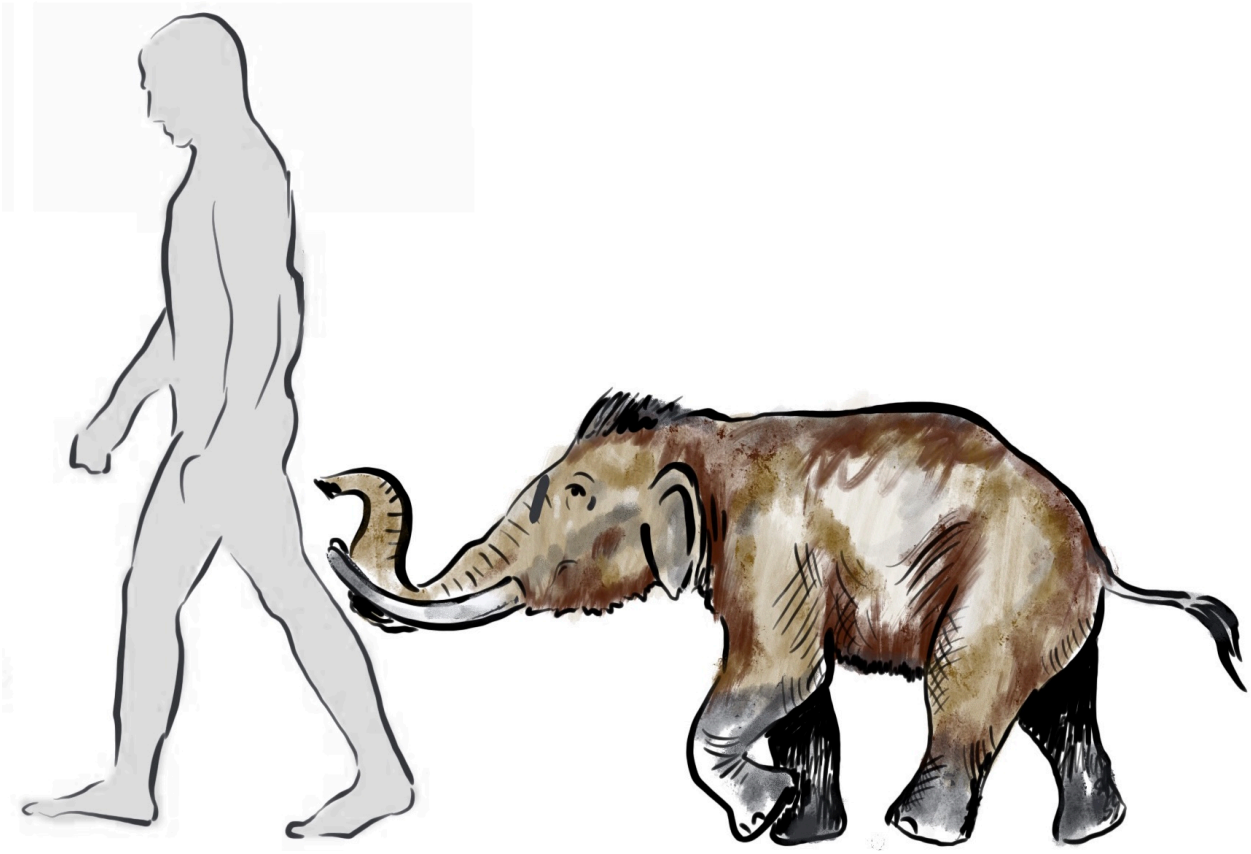

Illustration created by Domenico Fulgione

limited size. it is not a case the lack of fossils of elephants of medium size in the small islands because the proper environmental conditions to allow their survival did not subsist there: the only available niche was that for elephants of small size (but also for deer and dwarf hippos, of which we have found trace).

In all the islands of the Mediterranean, where we find in the larger mammals endemic forms of insular dwarfism, we necessarily have to hypothesize the presence of some wild dogs of small and medium sizes similar to the *Cynotherium sardous* or to the *Cynotherium malatestai* (whose fossils have been found in Sardinia and in Corsica): otherwise, in the lack of predators, the populations of elephants, bucks and endemic wild boars would have been exceedingly increased so impoverishing the insular resources at the limit and jeopardising their survival: it is an incontrovertible ethological datum. *Cynotherium sardous*, a wild dog of the fox size, lived during the Pleistocene, perhaps descending from *Xenocyon lycanoides*, *Canis arnensis* or *Cuon arnesi (*Abbazzi et al., 2005); it fed on small preys having a low sagittale crest and a slender jaw but the hypercarnivorous teeth allow to hypothesize that he could also chase large mammals such as the *Megaloceros*, a large Pleistocene deer. The other wild dog, *Cynotherium malatestai*, represents a transitional form between *Xenocyonly lycanoides* and *Cynotherium sardous*, being larger than the last and having a stronger jaw (Madurell et al., 2015). It can be hypothesized that *Cynotherium malatestai* occupied a different trophic niche, represented by the elephants and dwarf wild boars, which could be chased from the wild dogs in flock, thanks to the more robust jaws and skulls and of course of the size. One may however object: why so rarely on the Mediterranean islands have been found the remains of fossils dogs as the *Cynotherium malatestai*? The answer has perhaps to be searched in the same brittleness of the bones of these small mammals (as for mustelids and wild cats) as they can be shattered and lost more easily, while the strong bones of the insular endemic mammals such as those of the elephant and of the dwarf hippo are better preserved.

Conclusions

The key of point to understand the reduction and the difference of size of the insular elephants is multifactorial and therefore it is necessary to consider several complex interdependent factors, i.e. the limited natural resources, the size of the insular environment, the type of habitat (niches) and the geological period pertinent to the remains, and finally, the interaction with the predators present at that time.

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