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INFLUENCE OF THE CLIMATIC-ENVIRONMENTAL VARIATIONS ON THE VOLE *MICROTUS (TYRRHENICOLA) HENSELI* AT THE LATE PLEISTOCENE-HOLOCENE TRANSITION

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RIASSUNTO - *Influenza delle variazioni climatico-ambientali al passaggio Pleistocene superiore-Olocene sul roditore* Microtus (Tyrrhenicola) henseli - Il Quaternario *Italian Journal of Quaternary Sciences*, **9**(2), 1996, 721-724 - Una serie di analisi morfometriche e e della microstruttura dello smalto compiute sui primi molari inferiori (m1) di popolazioni del roditore endemico fossile *Microtus (Tyrrhenicola) henseli,* provenienti da località pleistoceniche ed oloceniche della Sardegna e della Corsica, ha evidenziato la presenza di significative tendenze evolutive in questa microtina insulare. Le popolazioni studiate sono state distinte in due gruppi caratterizzati da un diverso grado evolutivo, riferiti rispettivamente al Pleistocene medio-superiore e al tardo Pleistocene superiore-Olocene. Si è potuto anche rilevare un marcato aumento della taglia al passaggio tra le popolazioni del tardo Pleistocene a quelle dell'Olocene, non accompagnato da cambiamenti di altre caratteristiche morfologiche. Viene sollevata la questione se i cambiamenti morfologici osservati nelle forme del tardo Pleistocene siano stati influenzati dall'impatto antropico (ad esempio, l'introduzione di nuovi competitori e predatori), o siano piuttosto legati ai profondi cambiamenti climatico-ambientali della fine dell'ultimo glaciale. I cambiamenti di taglia che si osservano nelle popolazioni oloceniche in depositi di età neolitica sono più probabilmente da collegare alle trasformazioni ambientali prodotte dalla diffusione della cultura neolitica nelle due isole.

ABSTRACT - *Influence of the climatic-environmental variations on the vole* Microtus (Tyrrhenicola) Henseli *at the late Pleistocene-Holocene transition* - Il Quaternario *Italian Journal of Quaternary Sciences*, **9**(2), 1996, 721-724 - Morphometric and enemel microstructural analyses performed on the first lower molar (m1) of the endemic fossil vole *Microtus (Tyrrhenicola) henseli* from Pleistocene and Holocene deposits of Sardinia and Corsica highlight significant evolutionary trends in this insular vole. The studied populations are distinguished into two groups characterized by a different degree of evolution. It resulted that marked morphological changes occurred during the latest Pleistocene, whereas a marked increase in the teeth size, not associated with any other important morphological change, occurred at the transition from the late Pleistocene to Holocene populations. Size changes observed in Holocene populations from Neolithic deposits can more likely be referred to the environmental variations produced by the diffusion of the Neolithic Culture in the two islands.

Key words: Microtine, Rodentia, dental morphology, Pleistocene-Holocene transition
Parole chiave: Microtine, Rodentia, morfologia dentaria, transizione Pleistocene-Olocene.

1. INTRODUCTION

The amount of variations observed in the successions of rodent associations (disappearance of archaic species and appearance of new species), the rapid evolution of the phylethic lineages, and significant migratory events, make the Order Rodentia to be a primary factor in the elaboration of Quaternary detailed climatic stratigraphy. Of course, a good knowledge of systematics and of the main evolutionary tendency of taxa involved is needed for the purpose.

The faunal assemblage including *Microtus (Tyrrhenicola) henseli* — associated with *Prolagus sardus, Nesiotites similis, Megaceros cazioti, Rhagamys orthodon, Cynotherium sardous, Talpa tyrrhenica* and possibly *Macaca majori* — has been present in Sardinia even since the earliest middle Pleistocene (late early Biharian) when it is likely that, during a regressive phase, Sardinia was connected to the Italian peninsula through the Tuscan archipelago. These animals replaced the older assemblage, including *Nesiotites corsicanus, Nesogoral melonii, Prolagus figaro, Rhagamys minor, Tyrrhenoglis figariensis and Sus nanus* (Van der Made, 1988).

2. RESULTLS AND DISCUSSION

The evolution of the rodent *Microtus (Tyrrhenicola) henseli* populations during the time interval ranging from the middle Pleistocene to the Holocene, has been highlighted through a set of morphometric and enemel microstructural analyses performed on the first lower molar (m1). The study allowed to identify important evolutionary trends — many of which correlate with each other — which can be summarized as follows (Mezzabotta *et al.*, 1995; 1996):

– increase in tooth size;

– increasing elongation of ACC relative to the tooth total length;

– increasing elongation of AC2, coupled with further complication of its morphology;

– increase in the posterior elongation of the sixth triangle (T6);

– narrowing neck;

– slight increase in the narrowing of the pinching of the pitymyoid rhomb;

– general reduction in thickness of trailing edges with respect to the leading ones, coupled with reduction

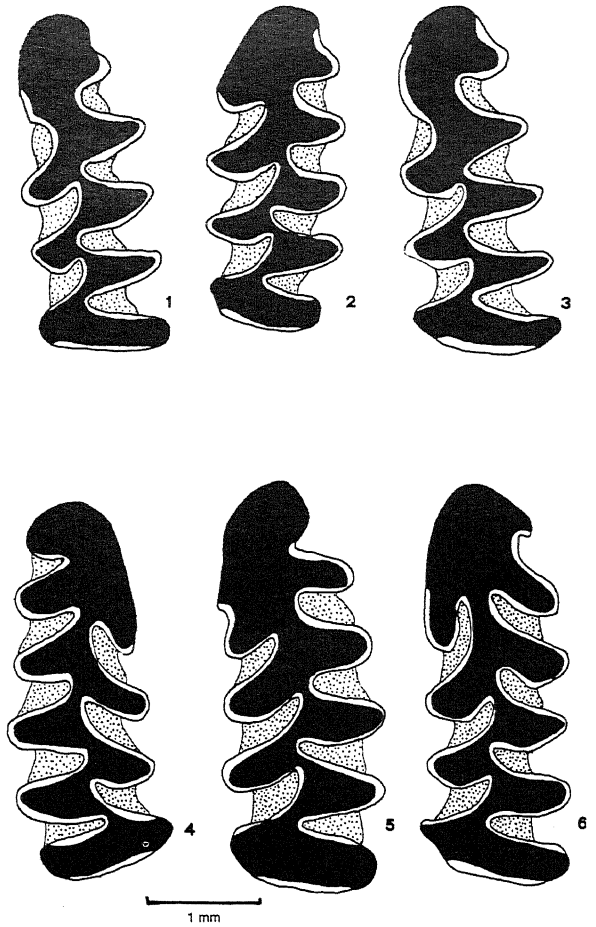


Fig.1 - Main morphotypes occurring in the Pleistocene populations of Sardinia (1-3), and in the late Pleistocene and Holocene populations of Sardinia and Corsica (4-6).

Morfotipi presenti nelle popolazioni pleistoceniche sarde (1-3) e nelle popolazioni tardo-pleistoceniche ed oloceniche della Sardegna e della Corsica (4-6).

of the zone of tangential enamel in the trailing edges.

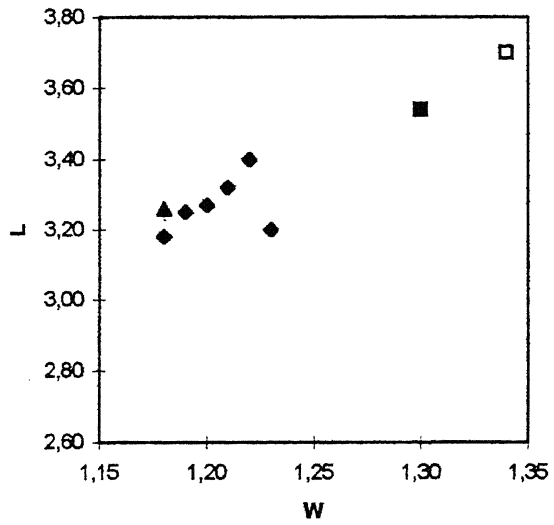
The study of populations coming from caves, karst fissures and bone breccias in Sardinia (Sanges & Alcover, 1980; Gliozzi *et al.*, 1984; Klein Hofmejer *et al.*, 1987) and from one Holocene deposit in northern Corsica, allowed to distinguish two groups of populations with different degrees of evolution (Mezzabotta *et al.*, 1995).

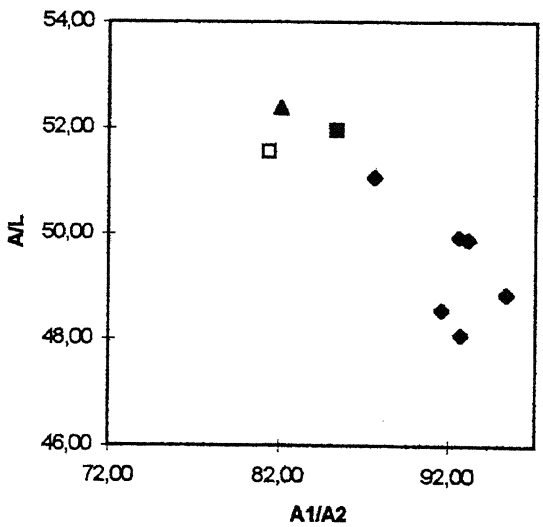
The first group, which is the most primitive, includes populations the age of which spans from middle to late Pleistocene. The other group is more evolved, and includes populations both from the latest Pleistocene to Holocene age ("Grotta Corbeddu" Cave, Sardinia) and of the Holocene ("Grotta Su Guanu" Cave, Sardinia; Fontaneddu, Corsica) (Fig. 1). In this second group, a marked increase in size, not associated with any significant changes of other morphological elements, can be evaluated in the transition from late Pleistocene to Holocene populations (Fig. 2).

This morphological trend, which was very clear in *Tyrrhenicola henseli* during the Late Glacial-early Holocene, could be explained in terms of response to the marked reduction — if not really to extinction — of its most common predators, such as the endemic canid *Cynotherium sardous,* which was found in level 3 of "Grotta Corbeddu" Cave (13,590±140 yr B.P.), whereas is absent in level 2 (9,120±380 yr B.P.) (Sondaar *et al.*, 1984; 1986).

The fact that the presence of larger-sized forms coincides with the diffusion of the Neolithic culture could also suggest a direct relationship between increase in size and environmental modifications — such as deforestation and diffusion of Gramineae — introduced by the Neolithic Man.

As to *Prolagus sardus,* different and more complex microevolutionary modifications affected this typical element of the *Tyrrhenicola* faunal assemblage. During the whole Pleistocene, *Prolagus* shows a general trend towards an increase in size (Tobien, 1935; Thaler, 1973; Lopez-Martinez & Thaler, 1975; Brandy, 1978), but, from the very early Holocene, the trend shifted to a marked reduction of the limb length (Vigne, 1983; 1992). This significant morphological change seems to coincide with the diffusion of Man. Man and the predators he introduced (*i.e.* wolf and domestic dog) surely determined a strong selective pressure on *Prolagus sardus,* which prob-





ably caused an increase of the fossorial attitude of this species, as suggested by the trend towards the reduction of the limbs.

The selective pressure of Man and of the newly introduced predators probably had not the same impact on the endemic vole *Tyrrhenicola henseli.* However, the fact that these endemic voles survived beyond the end of the Pleistocene in the Tyrrhenian islands seems to demonstrate that they had sufficient adaptative resources to counteract human impact and climatic-environmental modifications (Vigne, 1987; 1988).

It is difficult to evaluate the impact of the late Pleistocene glaciations on the climate, the landscape and the fauna of the insular environment of Sardinia. The micromammal fauna of Sardinia, as well as that of Corsica, had undergone other climatic crises during the preceding glacial and interglacial periods and, as reported also for the Italian peninsula, seems to have passed through the Late Glacial crisis unaltered. In the case of the Tyrrhenian islands, the influence of the sea certainly had a major role in favouring the development of highly diversified habitats in a restricted geographic area such as that of an island.

For a better evaluation it is important to take into consideration also the possible consequences of the anthropic impact, which surely produced deep "disequilibria" associated with marked changes, even in mammal assemblages. Ecosystems anthropization might have caused very deep changes which, together with climate, led to the extinction of *Tyrrhenicola henseli* in Sardinia during the Sub-Boreal. The later extinction of the microtine in Corsica could be explained in terms of an higher number of *refugia* for endemic fauna there.

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Fig. 2 - Bidimensional plots constructed by using the mean values of the morphological parameters and indexes. Legend: W = width of the pitymyoid rhomb; L = total length of the tooth; A1/A2 = posterior elongation of the sixth triangle (T6),with respect to the fourth buccal reentrant angle (BRA4); A/L = length of the anteroconid complex (ACC), with respect to the total length. Solid rhomb = middle to late Pleistocene deposits of Sardinia. Solid triangle = "Grotta Corbeddu" Cave (Sardinia) (latest Pleistocene-Holocene, 14,000 ÷ 8,000 yr. B.P.). Solid square = "Grotta Su Guanu" Cave (Sardinia) (Holocene, > 4.900 ÷ 4.830 ± 50 yr. B.P.). Open square = Fontaneddu (Corsica) (Holocene). See Mezzabotta *et al.* (1995) for details.

Diagrammi bidimensionali costruiti sui valori medi dei parametri e degli indici morfologici. Legenda: W = ampiezza del rombo-pitimioide; L = lunghezza totale del dente; A1/A2 = allungamento posteriore del sesto triangolo (T6) rispetto al quarto angolo rientrante sul lato labiale (BRA4); A/L = allungamento del complesso anteroconide (ACC) rispetto alla lunghezza totale del dente. Rombi pieni = depositi del Pleistocene medio e superiore della Sardegna. Triangolo pieno = Grotta Corbeddu (Sardegna) (Pleistocene superiore-Olocene, 14.000 ÷ 8.000 yr. B.P.). Quadrato pieno = Grotta Su Guanu (Sardegna) (Olocene, > 4.900 ÷ 4.830 ± 50 yr. B.P.). Quadrato vuoto = Fontaneddu (Corsica) (Olocene). Per maggiori dettagli, vedi Mezzabotta et al. *(1995).*

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