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QUATERNARY BIOGEOGRAPHY OF THE MUSTELIDAE FAMILY ON THE MEDITERRANEAN ISLANDS

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ABSTRACT – Five *taxa* of the Mustelidae family now occur on the Mediterranean islands: the pine marten, *Martes martes* L., 1758, distributed on some of the Balearic and Tyrrhenian islands, the stone marten, *M. foina* Erxleben, 1777, which occurs on many islands of the basin, the badger, *Meles meles* Brisson, 1762, that has been only reported from some Greek islands, the weasel, *Mustela nivalis* L., 1766, common to many of the islands, and the otter, *Lutra lutra* L., 1758, recorded from the Greek islands. During Late Pleistocene times, only few carnivores seem to have occurred, however, on these islands and none is referable to the species that are present today. Paleontological evidence attests only to the occurrence of endemic elements, most of which were related to the Lutrinae subfamily. Apart from *L. lutra*, the absence during Late Pleistocene and Early Holocene of the continental species present today suggests that these carnivores are allochthonous. They were imported by man, for various purposes, probably since prehistorical and/or early historical times.

Key words: Quaternary, Mustelidae, Mediterranean islands, Biogeography.

RIASSUNTO – *Biogeografia quaternaria della famiglia Mustelidae nelle isole del Mediterraneo* – La distribuzione attuale dei rappresentanti della famiglia Mustelidae nelle isole mediterranee interessa esclusivamente cinque specie: la martora, *Martes martes* L., 1758, presente su alcune isole baleariche e tirreniche, la faina, *M. foina* Erxleben, 1777, diffusa in varie isole del Mediterraneo, il tasso, ***Meles meles*** Brisson, 1762, che viene solo segnalato per alcune isole greche, la donnola, *Mustela nivalis* L., 1766, che interessa molte isole del bacino e la lontra, *Lutra lutra* L., 1758, nota solamente per alcune isole greche. Nel corso del Pleistocene altre forme di mustelidi hanno comunque interessato queste isole e nessuna di esse puo essere riferita tassonomicamente a quelle oggi presenti. Il Quaternario delle isole mediterranee è infatti esclusivamente caratterizzato dalla presenza di mustelidi endemici, appartenenti per la maggior parte alla sottofamiglia Lutrinae. Fatta eccezione per *L. lutra*, l'assenza durante il tardo Pleistocene e l'Olocene antico dei mustelidi continentali, oggi presenti sulle isole, suggerisce un'origine antropocora della loro diffusione. Essi devono essere stati infatti introdotti dall'uomo, per ragioni diverse, fino dalle epoche preistoriche e/o protostoriche.

Parole chiave: Quaternario, Mustelidae, Isole mediterranee, Biogeografia.

INTRODUCTION

At present, the Mustelidae family is the taxonomic group of carnivores most widespread on the islands of the Mediterranean basin. The Canidae, essentially represented by *Vulpes vulpes* (L., 1758) are distributed on Corsica, Sardinia, Sicily, some of the Greek islands and Cyprus (Corbet, 1978; Spitzenberger, 1979; Adamakopoulos **et** al., 1991; Macdonald & Barrett, 1993); on the latter island the fox is the only wild carnivore present today. Wild cats are reported from Mallorca, Corsica, Sardinia, Sicily and Crete (Miller, 1912; Corbet, 1978), but further investigations are needed to define better the taxonomic position of the different island forms. Viverridae are represented by the common genet, *Genettu genetta* (L., 1758), only on the Balearics, on the islands of Mallorca, Ibiza and Cabrera (Alcover, 1979; Clevenger, 1993). With the exception of the ferret, which is to be considered a domestic form derived from the polecat, *Mustela putorius* L., 1758, of the nine wild forms of Mustelidae, that are presently distributed throughout Southern Europe, the Near East and North Africa, only five *taxa* are dispersed on the Mediterranean islands.

The aim of the present work is to provide a review of the previous knowledge of the mustelids' Quaternary distribution on the Mediterranean islands, focusing on the Pleistocene-Early Holocene occurrence of endemic species and on the first appearance on the islands of the extant continental forms.

THE NON ENDEMIC QUATERNARY MUSTELIDAE OF THE MEDITERRANEAN ISLANDS

Even if with subspecific forms, some times classified by former authors essentially on the basis of arbitrary criteria, the island scenario is today dominated by the presence of a few mustelid species of continental origin (Fig. 1). These species are, in fact, widespread on the closest Palaearctic land-masses.

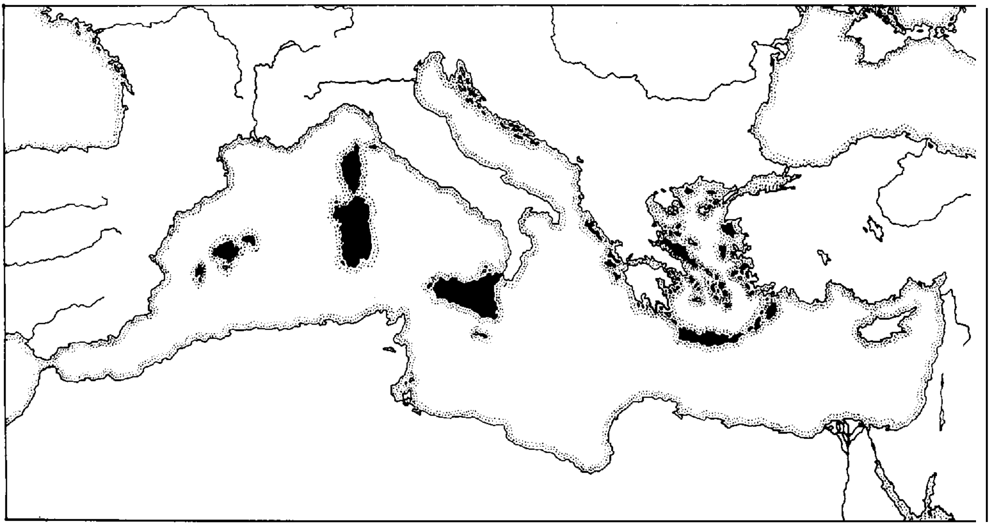

Fig. 1 – Present distribution of the representatives of the Mustelidae family on the Mediterranean islands.

Weasel, *Mustela nivalis* L., 1766

Considered by some authors a definite Pleistocene rodent specialist, the common weasel seems to have made its first appearance in Europe during the Mindel glacial episode (about 400,000 years ago) and is commonly found in cave deposits from the beginning of the Late Pleistocene (Kurtèn, 1968; King, 1989). It represent a Palaearctic species of the Euro-Siberian Region, widely distributed in

Europe and Asia (Corbet, 1978), and also present in North Africa (Atallah, 1978; Kowalski & Rzebik-Kowalska, 1991).

In the Mediterranean region, the weasel occurs today in northern Maghreb (Morocco, Algeria and Tunisia) (Osborbe & Helmy, 1980; Aulagnier, 1990; Kowalski & Rzebik-Kowalska, 1991; Zyll De Jong, 1992), in most of southern Europe and in Anatolia (Corbet, 1978; King, 1989; Harrison & Bate, 1991; Macdonald & Barrett, 1993). In the Levant its distribution is restricted to the northern areas of the region, including Lebanon (Harrison & Bate, 1991) and northern Syria. In the northern Arabian peninsula, it has not been reported since the Early Bronze Age (Boessneck, 1977; Dayan & Tchernov, 1988). In fact, in Israel, the species does not exist at present (Dayan & Tchernov, 1988; Dayan, 1989). Beyond this distribution gap in Israel, the common weasel occurs again in Egypt, along the Nile delta and valley, with a population characterized by large body size. This Egyptian population is almost completely commensal with man (Osborne & Helmy, 1980) and has been occasionally considered either a Roman introduction (Ruppell, 1826) or a glacial relic (Dayan & Tchernov, 1988). Even if they do not reach the size of the Egyptian weasel, the Mediterranean M. nivalis are all characterized by a very large body size (King, 1989).

Within the Mediterranean basin, the species occurs today on the following islands:

Balearic islands: Menorca (Miller, 1912; Alcover, 1979); Mallorca (Miller, 1912; Alcover, 1979; Aritio, 1984);
Corsica (Cavazza, 1908; Miller, 1912; Toschi, 1965; Vigne, 1992);
Sardinia (Forsith Major, 1882; Cavazza, 1912; Miller, 1912; Ellermann & Morrison-Scott, 1951; Toschi, 1965; Schenk, 1976; Zyll de Jong, 1992);
Asinara (Cossu et al., 1994)
Sicily (Miller, 1912; Toschi, 1965; Catalisano et al., 1991; Zyll de Jong, 1992);
Malta (Miller, 1912; Ellerman & Morrison-Scott, 1951; Toschi, 1965);
Ionian islands: Corfu (Grèmillet, 1993 pers. comm.);
Aegean islands: Thera (Douglas, 1892); Skopelos (Ciani, 1993 pers. comm.);
Crete (Bate, 1905; Zimmermann, 1952; Douma-Petridou & Ondrias, 1986; Zyll de Jong, 1992).

Pine marten, *Martes martes* (L., 1758)

Fossil remains of the pine marten have been identified in European deposits from the beginning of the Late Pleistocene (about 120,000-100,000 years BP) (Kurtèn, 1968). According to Anderson (1970), "the Wurm and Postglacial martens were larger than their extant relatives, and there has been a rather steady decrease in size since Postglacial times". It is a typical element of the western Palaearctic Region (cf. Ellermann & Morrison-Scott, 1951; Corbet, 1978).

In the Mediterranean region, the species occurs at present throughout southern Europe (France and Italy), except for most of Iberia, where it is confined to the northern areas, and most of the Balkan peninsula (Corbet, 1978; Macdonald & Barrett, 1993). Its occurrence is not reported from Anatolia and the Levant (cf. Harrison, 1968; Harrison & Bate, 1991). The species is completely absent from North Africa. It is distributed on the following Mediterranean islands:

Balearic islands: Menorca (Alcover, 1979; I.C.O.N.A., 1986; Clevenger, 1993); Mallorca (Alcover, 1979; Clevenger, i 993);

Tuscan archipelago: Elba (Branchi, 1839; Zuccagni-Orlandini, 1842; Lanza, 1970; Vigna Taglianti, 1988; De Marinis & Masseti, 1993a, 1993b);

Sardinia (Barrett-Hamilton, 1904; Cavazza, 1912; Hutterer & Geraets, 1978; Murgia et al., in this volume);

Sicily (Cavazza, 1912; Toschi, 1965; Corbet, 1978; Vigna Taglianti, 1988; Catalisano et al., 1991).

Formerly recorded by Forsyth Major (1882), the pine marten has also been recently reported from Corsica by Verbeek (I 974) and by Cholley (1982). However, according to Vigne (1992), the occurrence of the species on the island is at present still uncertain. With the exception of Elba, on the other islands of the Tuscan archipelago, there is no longer evidence for the occurrence of the species, which has however been recorded in the Twentieth century from the islands of Pianosa (Sommier, 1909; Lanza, 1970), Montecristo (Angelelli, 1903; Toschi, 1953), and Giglio (Sommier, 1900).

Stone marten, *Martes foina* Erxleben, 1777

Fossil remains of this species have only been reported from Postglacial deposits in Europe, where it probably entered from the Near East at the end of the Pleistocene or in Early Holocene times (Kurtèn, 1968; Anderson, 1970; Sala, 1992). It may be possible that, at the time of its prehistoric arrival in Europe, the stone marten was a follower of human cultures (Anderson, 1970). It represent a Palaearctic species characteristic of the Irano-Turanian Region penetrating into the Mediterranean Region (Atallah, 1978). At present the taxon is distributed throughout most of southern Europe, including Iberia, southern France, Italy and the Balkan peninsula. In the Mediterranean Near East, its range occurs throughout Anatolia and the Levant up to the latitude of the Dead Sea (Mendelssohn & Yom Tov, 1987; Harrison & Bate, 1991).The species is absent from North Africa.

It is largely widespread on the islands of the eastern Mediterranean basin:

Ionian islands: Corfu (Niethammer, 1962; Douma-Petridou, 1984; Grèmillet, 1993 pers. comm.); Leucas, Zakynthos and Ithake (Douma-Petridou, 1984); Keffalinia (Miller 1912; Douma-Petridou, 1984);

Aegean islands: Kythera (Mylonas, 1994 pers. comm.). Evoia, Thassos, Samos, Ithaki, Lesbos, Chios, Ikaria, Thera and Kos (Douma-Petridou, 1984); Skopelos (Ondrias, 1965; Douma-Petridou, 1984; Ciani, 1993 pers. comm.); Alonissos (Ciani, 1993 pers. comm.); Naxos (Ondrias, 1965; Douma-Petrodou, 1984); Erimomilos (Koller, 1928); Karpathos (De Beaux, 1929; Douma-Petridou, 1984); Samotrake (Ondrias, 1965); Serifos (Ondrias, 1965; Douma-Petridou, 1984); Kytnos (Wettstein, 1942; Douma-Petridou, 1984);

Crete (Barrett-Hamilton, 1899; Bate, 1905; Zimmermann, 1952; Ondrias, 1965; Niethammer & Niethammer, 1967; Douma-Petridou, 1984; Masseti, in this volume);

Dodecanese islands: Rhodos (Festa, 1914; Wettstein, 1942; Douma-Petridou, 1984).

On the islands of the western Mediterranean basin the species occurred only on Ibiza where it became extinct in the early 1970s (Delibes & Amores, 1986).

Eurasian badger, *Meles meles* (L., 1758)

The species has been definitely identified from European fossil deposits from the early Middle Pleistocene, even if "occasionally the burrowing habits of the badger may lead to its bones being deposited in strata formed at a much earlier date" (Kurtèn, 1968). It constitutes a Palaearctic species of the Euro-Siberian Region, distributed in Europe and Asia but absent from North Africa (Atallah, 1978; Kowalski & Rzebik-Kowalska, 1991).

In the Mediterranean region, the badger now inhabits most of southern Europe (Corbet, 1978; Macdonald & Barrett, 1993), Anatolia and the Levant (Mendelssohn & Yom Tov, 1987; Harrison & Bate, 1991).

Among the Aegean islands the taxon has been reported from Tinos, but it might also be present on other islands, such as Siphnos and Andros (Adamakopoulos et al., 1991). Its occurrence on Crete has been referred by Barrett-Hamilton (1899), Bate (1905), Miller (1912), Zimmermann (1952), Ondrias (1965), Adamakopoulos et al. (1991), and Legakis (1992 pers. comm.); in the Dodecanese archipelago the presence of the badger was recorded on the island of Rhodes by Festa (1914), Wettstein (1942), Ondrias (1965) and Adamakopoulos et al. (1991).

The occurrence of the species was erroneously recorded by Corbet (1978) on the Balearic archipelago.

Eurasian otter, *Lutra lutru* (L., 1758)

In Europe, *L. lutru* is only known with certainty from Holocene fossil deposits. In fact, there is no indisputable proof of its Pleistocene occurrence (Willemsen, 1992). It represent a Palaearctic species of the Euro-Siberian Region, widely distributed in Europe and Asia, and also present in North Africa (Atallah, 1978; Kowalski & Rzebik-Kowalska, 1991).

The Mediterranean diffusion of the otter now occurs throughout most of southern Europe (Macdonald, 1991), including Albania (Prigioni et al., 1986) and ex-Yugoslavia (Liles & Jenkins, 1984), Anatolia (Harrison & Bate, 1991) and the Levant, where it is reported from northern Israel (Mendelssohn & Yom Tov, 1987; Foster-Turley, 1991). In North Africa, the range of the species is essentially restricted to the coasts and the foothill of Morocco and to the coastal region of Tunisia and Algeria (Haltenorth & Diller, 1980; Mason & Macdonald, 1986; Kowalski & Rzebik-Kowalska, 1991; Rowe-Rowe, 1991).

The present occurrence of otters on the Mediterranean islands is documented only for some of the Greek islands (cf. Macdonald, 1991), located very near the mainland coasts of Greece and Albania. *L. lutru* is reported, on the Ionian islands, from Corfu (Prigioni et al., 1986; Gaetlich, 1988; Adamakopoulos et al., 1991; Macdonald, 1991; Grèmillet, 1993 and in this volume), and on the Aegean islands from Euboea (Adamakopoulos et al., 1991; Macdonald, 1991); and Chios (Adamakopoulos et al., 1991; Grèmillet, 1993 pers. comm.). It cannot be excluded that these populations have regular contacts and exchanges with continental groups. In fact, it may also be possible that some of the otter populations of the Balkan peninsula alternate between marine and freshwater habitats. Further investigations on the Ionian and Aegean islands will probably provide evidence of the occurrence of other populations.

ENDEMIC QUATERNARY MUSTELIDAE OF THE MEDITERRANEAN ISLANDS

As already observed, the modern mammalian fauna composition of many Mediterranean islands comprises some representatives of the Mustelidae family which are also distributed on the closest Palaearctic land-masses. However, during Middle and Late Pleistocene other species of the Mustelidae family occurred on the islands. None of the fossil remains of the *taxa* that inhabit at present the Mediterraean islands seem to be referable to the Quaternary species as far reported. Paleontological evidence attests only to the occurrence of endemic elements that characterized the Quaternary island faunas. **A** survey of the paleontological literature yields a considerable amount of Quaternary fossil species. It generally can be stated that all these mustelids show strong endemic patterns and almost all of them are characteristic of a different insular complex. The following endemic species have so far been described from the Pleistocene of the Mediterranean (Fig. 2):

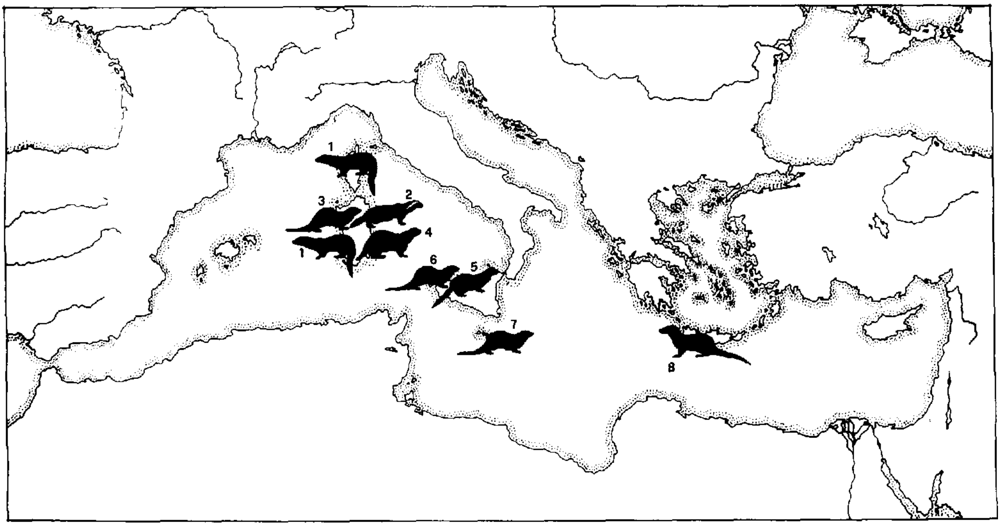

Fig. **2** – Distribution of the Quaternary endemic representatives of the Mustelidae family on the Mediterranean islands: 1. *Algarolutra majori*; 2. *Enhydrictis galictoides*; 3. *Sardolutra ichnusae*; 4. *Megalenhydris barbaricina;* 5. *Mustela arzilla;* 6. *Lutra trinacriae*; 7. *Lutra euxena*; 8. *Lutrogale cretensis*.

CORSICA

Algarolutra majori (Malatesta, 1978) (Helbing, 1935; Malatesta 1970 and 1978; Willemsen 1992), from Grotta del Margine. This otter was also reported from the Quaternary of Sardinia.

Stratigraphic occurrence: Late Pleistocene.

TUSCAN ARCHIPELAGO

An undetermined *Mustela* sp. was quoted by former authors, such as Gastaldi (1866), Rutimeyer (1866), Simonelli (i889), Forsyth Major (1882) and Stehlin (1928), among the Pleistocene fossil fauna of the small Tyrrhenian island of Pianosa (De Giuli, 1970; Azzaroli, 1978). De Stefano (1913) made a revision of the Pianosa materials but he did not recognize any fossil remains of Mustelidae. *Mustela* sp. was quoted among the fauna discovered in the caves eroded by the sea in the coastal cliffs and related to human industry ranging from the Late Palaeolithic to Neolithic (Azzaroli 1978). The associated fauna displayed strong continental patterns, including ***taxa*** such as *Mus, Lepus, Sus* and *Ovis*.

SARDINIA

Enhydrictis galictoides Forsith Major, 1901, a semi-aquatic (Ficcarelli & Torre, 1967; Azzaroli, 1971) or, more probably, a land Mustelidae (Kurtèn, 1968), smaller than a common otter, and, according to Ficcarelli & Torre (1967), related to the Villafranchian *Enhydrictis ardea* (Bravard, 1828) and included in the Grisoninae subfamily, Pockok 1921 (Ficcarelli & Torre, 1967). These fossil remains were found at Monte San Giovanni, Capo Figari, San Giovanni (Iglesias) and Grotta della Dragonara (Capo Caccia).

Stratigraphical range: Middle Pleistocene.

The species might have reached Sardinia, probably from the Italian mainland through Corsica, between the Late Villafranchian and the Galerian (Ficcarelli & Torre, 1967; Azzaroli, 1983).

Sardolutra ichnusae (Malatesta, 1977), a sea otter from Grotta di Nettuno, Capo Caccia (Malatesta, 1977; Willemsen, 1992).

Stratigraphic occurrence: probably Upper Pleistocene or Holocene.

According to Willemsen (1992), this not very large species shows stronger aquatic adaptations than *L. lutra* (L., 1758) and was a marine fish-feeder.

Algarolutra majori (Malatesta, 1978), a Lutrinae from the Grotta di Dragonara, near Alghero (Helbing, 1935; Malatesta, 1970 and 1978; Willemsen, 1992). As noted above, this form was also found in Corsica.

Stratigraphic occurrence: Late Pleistocene.

A not very large species that probably fed on fish and shellfish (Willemsen, 1992).

Megalenhydris barbaricina Willemsen & Malatesta, 1987, from Ispiginoli, near Dorgali (Malatesta, 1977 and 1978; Sondaar, 1978; Willemsen & Malatesta, 1987; Willemsen, 1992).

Stratigraphic occurrence: Willemsen & Malatesta (1987) presumed a Late Pleistocene or Holocene age.

A very large species that probably preyed on large fish and shellfish. It was probably a rather aquatic lutrine and the clear flattering of the tail indicates that it was a very good swimmer (Willemsen, 1992).

SICILY

Mustela (Mustelercta) arzilla De Gregorio, 1886, a large polecat-like carnivore (Burgio & Fiore 1993 pers. comm.), probably endemic to the peak of Monte Pellegrino (Palermo), and that might date to the Late Villafranchian (Fiore 1993, pers. comm.).

Stratigraphic occurrence: probably Late Pliocene-Early Pleistocene (De Gregorio, 1886; Thaler, 1972; Burgio & Fiore, 1988a). It seems that the form might be referable to the genus *Pannonictis*, dispersed in Europe during the Villafranchian (Palombo, 1985; Fiore I993 pers. comm.).

Lutra trinacriae (Burgio & Fiore, 1988b), a middle size Lutrinae found in the Poggio Schinaldo Cave (Palermo), associated to Middle-Upper Pleistocene fauna (Esu et al., 1986; Pennacchioni & Cassola, 1986; Burgio & Fiore, 1988b; Willemsen, 1992).

Stratigraphic occurrence: Middle or Late Pleistocene. The species shows stronger aquatic adaptation than *L. lutra* (Willemsen, 1992).

MALTA

Lutra euxena (Bate, 1935), a Lutrinae, associated to Pleistocene fauna, from Tal Gnien, near Imkabiba, southwest of La Valletta (Bate, 1935; Thenius, 1951 and 1962; Kurtèn, 1968; Esu et al., 1986; Willemsen, 1992).

Stratigraphic occurrence: Pleistocene.

The species shows stronger aquatic adaptation than the common otter (Willemsen, 1992).

CRETE

Lutrogale cretensis (Symeonidis & Sondaar, 1975), from Liko Cave, near Georgioupolis.

Stratigraphic range: Late Pleistocene.

This species seems more adapted to land than *L. lutra* (L., 1758) (Sondaar, 1977). According to Symeonidis & Sondaar (1975), Sondaar (1977) and Willemsen (1980 and 1992), it was more specialized to a terrestrial habitat than *L. lutra*.

The island of Cyprus, in the eastern Mediterranean basin, did not provide any fossil remains of endemic mustelids. However, Bate (1903) described a fossil mandibular ramus of a Pleistocene island carnivore as the endemic form *Genetta plesictoides,* intermediate between the extant viverrid *G. genetta* and a mustelid of the European Oligocene, *Plesictis croizeti* Pomel, 1846. **As** observed by Wolsan (1993), the earliest students of the *taxon Plesictis* (e.g. Pomel, 1853) regarded it as a viverrid, but most later authors associated this genus with mustelids. On the basis of the small amount of data, however, Boekschoten & Sondaar (1972) do not consider Bate's genet a fully established member of the Cypriot island fauna. Further investigations are however needed to define better the taxonomic position of this fossil form.

THE ARRIVAL OF CONTINENTAL MUSTELIDS ON THE ISLAND

Among the first occurrence of continental mustelids so far documented on the Mediterranean islands, one should mention that of *M. nivalis* and *M. martes* in the Terminal Pleistocene of Uzzo Cave, on Sicily (Tagliacozzo, 1993). This large Italian island was in fact joined by a temporary land-bridge that originated as a result of the lowering of the sea-level during the highest peak of the last Glacial episode (Azzaroli, 1971 and 1978). Thus, the endemic Sicilian fauna was wiped out by a wave of immigration of new mammals from the mainland, including continental mustelids. Remains of *M. foina* and *M. meles* associated with Late Pleistocene endemic insular faunal elements, have been recorded from Simonelli Cave, near Rethymnon, on Crete (Caloi, 1980). But the conditions of their preservation make it likely they are subfossil material (Kotsakis, 1990). In fact, Crete was not joined to the mainland during late Pleistocene times and it cannot be excluded that the occurrence of both species among earlier stratigraphic levels is related to the animal's digging abilities. An adult *M. meles* skull and a *M. foina* skull were also collected by S.E. Kuss respectively in Mavromouri cave I and in Mavromouri cave VII, which also produced Pleistocene fauna remains (D. Reese pers. comm.).

The island of Rhodes perhaps provides the oldest findings of continental mustelids discovered up to now in island archaeological contexts. They are represented by the remains of a marten, yielded by the Ceramic Neolithic levels of Kalythies, and presumed on biogeographical grounds to belonged to stone marten (Halstead and Jones, 1987). Continental mustelids have also been reported from several archaeological sites on Crete. One *M. meles* bone was in fact discovered in the Aceramic Neolithic level at Knossos, while Ceramic Neolithic and later levels produced numerous remains of the same species (Jarman n.d.; David Reese pers. comm.). Osteological remains of the badger were also found in the site of Aghia Triada, in the south of the island, and have been referred to the Ancient Minoan period (about 3,000-2,200 B.C.) (Wilkens, in press). Osteological remains of this species are also known from Late Minoan IIIC Kavousi-Vroda (Klipper & Snyder, 1991). The stone marten has been reported from Gerani cave 11, associated with both Pleistocene and Neolithic faunas (D. Reese pers. comm.), and from Early Neolithic Minoan Knoan Knossos (Jarman n.d.; D. Reese pers. comm.). The excavations of Aghia Triada also yielded remains of *Martes* sp., discovered with other remains of badgers in the levels of the Late Minoan period (about 1,550-1,500 B.C.) (Wilkens, in press).

Remains of *M. nivalis* were found, however, on the island of Cyprus, where continental Mustelidae are at present unknown. Two subfossil skulls of weasel were reported from the archaeological site of Enkomi-Alasia, which dates to the Bronze Age (1,600-1,050 B.C.), in eastern Cyprus (Lehmann & Nobis, 1979). A femur of a small carnivore, similar in size to a stoat and presumably belonged to a weasel, has been discovered among the copper age materials of the Xemxija tombs, on Malta (Pike, 1971).

On the Balearic islands is possible so far to indicate the first arrival of the weasel during the first century B.C. An incomplete mandible of *M. nivalis* was in fact found on Menorca, in sample 5 (level IV, sector U) of the excavations of the Taula Torralba d'en Salort (Alaior). Another specimen, a juvenile cranium, was found together with remains of the Punic period (about 400 B.C.- 100 A.D. This finding does not contradict an introduction in the first century B.C., or immediately before (Sanders & Reumer, 1984) (Fig. *3).*

The pine marten and the weasel might also have been introduced on Corsica and Sardinia during the Roman period, or shortly before (Masseti, 1993). Until now, however, no completely satisfactory explanation has been produced for the time of the importation of these mustelids on both Tyrrhenian islands (Vigne, 1990 and 1992).

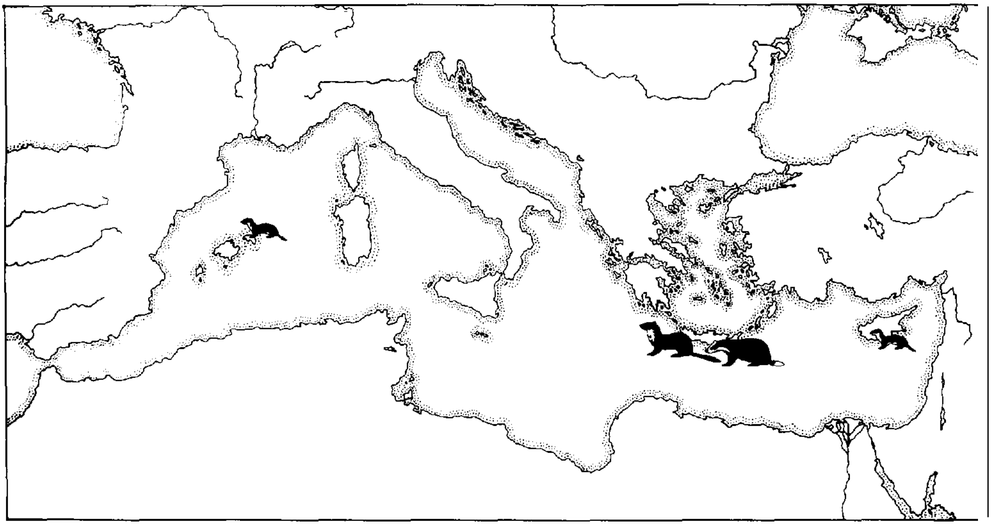

Fig. 3 – Mediterranean islands that yield the first archaeological evidence of the arrival of continental mustelids (drawings by Silvia Cantagalli Masseti).

CLOSING REMARKS

The Quaternary mammalian faunas of the Mediterranean islands were defined as unbalanced due to the general lack of carnivores (Sondaar, 1977; Dermitzakis & Sondaar, 1979). Willemsen (1992) tries to explain this character of the faunal composition observing that carnivores are worse swimmers than other *taxa* which dominated the endemic island faunas. In this view, otters represent the exception, and, as seen before, they are indeed found in many of the island endemic faunas. According to Burgio & Fiore (1988b), otters represent the only carnivores compatible to the unbalanced island faunas, because they cannot be considered real mammal predators due to their specialized food habits. The absence, during Late Pleistocene and Early Holocene, of the allochthonous mustelids present today suggests that these were imported by man on the Mediterranean islands for various purposes from ancient times. Since then, a process of exploitation of the natural resources and the environment has continued.

Evidence of the first introduction of mustelids on the Mediterranean islands is so far documented only for early historical times, but it can be assumed that this importation might have taken place even earlier. In fact, with the exception of dogs which merit a separate discussion, the importation of carnivores on the islands is a phenomenon registered since practically the earliest Neolithic colonization of the Mediterranean basin. Evidence for the introduction of the cat has been found in the Aceramic Neolithic (Davis, 1989) and in the Pottery Neolithic (Legge, 1982) on Cyprus, whereas foxes made their first appearance among insular faunas in the Ancient Neolithic on Corsica (Vigne, 1988 and 1992) and Sardinia (Masseti & Vianello, 1991; Masseti, 1993), and in the Aceramic Neolithic on Cyprus (Davis, 1984). More specifically, Vigne (1988) observes that, in most of the Mediterranean area, *V. vulpes* is the object of particular human attention during the Ancient Neolithic, when the canid might have been important both symbolically and as food. This cultural significance attributed to foxes by Ancient Neolithic man might appear more understandable when compared to the attitude held generally by Prehistoric peoples towards natural sources. Organic remains found in the excavations of early prehistoric sites show that humans ate a great variety of foods, from the meat of deer, to small and medium-sized carnivores, hedgehogs, fruits and seeds (Clutton-Brock, 1981). According to Jarman (1972), the analysis of the remains of mammals found in 165 late Paleolithic and Mesolithic sites of Europe reveals that foxes were more abundant than wild goats and lagomorphs, and that badgers, wild cats and martens were more common prey than elks, chamoises and bisons. Small and medium-sized Carnivores not only provided food supplies to prehistoric man. They might also have been utilised for their fur, as suggested by Grundbacher (1992) for the pine martens discovered in the excavations of the Neolithic site at Twann, in Switzerland.

As claimed by Miller as earlier as 1912, the modern distribution of mustelids, such as the weasel, on the Mediterranean islands as well as on some Atlantic islands has been influenced by man. In fact, apart from the otter which seems not to have undergone any taming attempt by man, the present distribution of mustelids on the Mediterranean islands reveals its anthropochorous origin. The times and the means of their introduction, however, are still scantily known. That some species of Mustelidae were employed as house animals in Classical Antiquity is sufficiently documented. Some of these species were, in fact, probably kept in semi-domestic conditions. Eminent witnesses of this custom were the Greeks Aristophanes and Aristotle, or the Latins Pliny the elder and Strabo. In their works they documented how carnivores, such as the *ictis* and the *gale*, which today might be identified with weasels, polecats or martens, were used to keep cupboards and barns clear of unwanted scavengers such as small rodents, during an age when the use of the cat as a domestic animal was still unknown: with the exception of ancient Egypt, the domestic cat was unknown along the Mediterranean shore before the late Roman period (cf. Zeuner, 1963). Remnants of this ancient practice of taming mustelids for domestic use can be seen even today in the use of the ferret for rabbiting, which still persists in some parts of Europe. These considerations, however, still might not explain satisfactorily that the anthropical introduction of the mustelids on the Mediterranean islands occurred in prehistorical times. The evidence, however, suggests that these continental carnivores were imported voluntarily by man. In fact, mustelids and genets would not have been able to pass unobserved on board the small boats employed to reach the Mediterranean islands (Vigne & Alcover, 1985).

Given the present state of paleontological knowledge, it can be assumed that the extant weasels, pine martens, stone martens and badgers on the Mediterranean islands originate from a former colonization resulting from the activity of man, in line with the theory that most of the recent mammalian fauna has been undergone a process of anthropical redefinition of the ecological equilibrium begun in prehistorical times (cf. Alcover, 1980; Sanders & Reumer, 1984).

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