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Ancient introductions of mammals in the Mediterranean Basin and their implications for conservation

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ABSTRACT

1. The importance of taxonomy to the determination of conservation priorities and actions is widely accepted. It should be not surprising therefore that the taxonomic treatment of mammal species that have been subject to human actions in antiquity may well influence the contemporary assessment of conservation priorities at various levels.

2. As a result of early extinctions caused by humans and protohistoric and historic introductions, we suggest that the Mediterranean Basin and its islands are particularly prone to misdirection of efforts towards biodiversity conservation.

3. The two main risks associated with the failure to use an evolutionary and palaeoecological approach to conservation efforts are (i) an underestimation of the conservation importance of distinctive continental taxa vs. the apparent endemicity of island taxa; and (ii) a serious risk for native and endemic island species when anthropochorous mammals, especially ungulates, misguidedly become the focus of conservation actions, particularly inside protected areas.

4. Urgent measures, including refinement of mammal taxonomy, the exclusion of known anthropochorous taxa from conservation lists and implementation of protective legislation, are necessary to maintain the uniqueness and richness of the Mediterranean biodiversity hotspot.

Keywords: conservation priorities, introduced mammals, legislation, Mediterranean Basin, taxonomy

INTRODUCTION

Even within this current fashionable period for biodiversity research, identification of what is worth saving and of the priorities necessary to maintain it are unlikely to be achieved for other than a minimum of selected, charismatic or useful taxa or habitats. Although taxonomy has long been considered crucial in conservation choices (Daugherty *et al.*, 1990), there is enough evidence that a classical typological taxonomy may be a poor basis for conservation planning (Ryder, 1986).

Despite this, it has often been recognized that named taxa have more chance of being protected (Rojas, 1992), especially through inclusion in national and international protective legislation. It is evident that taxonomy must reflect adequately the evolutionary differences among taxa, so that protective legislation and limited conservation funds are allocated effectively to deserving, truly divergent, threatened taxa (Ryder, 1986). Outdated typological thinking, parochialism and lack of integration with other scientific disciplines, such as palae-

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ontology and zooarchaeology, have all conspired to give a high conservation priority to named taxa whose ancient origin has been the consequence of human intervention (Gippoliti & Amori, 2002a defined anthropochorous taxa as those introduced populations that have been formally described taxonomically). This approach has led to an obvious but often overlooked misallocation of resources owing to poor taxonomy.

Possibly, in no other part of the world is this problem so serious as in the Mediterranean Basin, one of the 25 biodiversity hotspots recognized by Myers *et al*. (2000). Here, human civilizations have been present continuously for at least 9000 years, modifying entire landscapes and disrupting or destroying most native biocoenoses. Even prior to this long period, island mammal faunas had been heavily affected by humans, experiencing, particularly on the Mediterranean islands, an almost total extinction (Blondel & Vigne, 1993; Schüle, 1993). A conservation strategy whose aim is to maintain biodiversity and its evolutionary potential should not ignore the history (including recent history) of regional biota. This may be crucial to (i) identify and direct attention towards the taxa which escaped extinction events of the past and which maintain unique phylogenetic information; and (ii) evaluate each species' role in island ecosystems and help to find solutions to possible conflicts between anthropochorous and native or endemic taxa.

In the present paper, we present an overview of the scientific evidence concerning the recent anthropogenic origins of many Mediterranean mammal populations so attempting to redress conservation interest from Latin trinomials and binomials – to evolutionary significant units. After an overview of current international legislation and of conservation lists, implications for conservation policy are discussed and some proposals made.

EVIDENCE OF HUMAN INTERVENTIONS

Palaeo and Archaeo-zoological evidence

Most Mediterranean islands, including palaeo-islands such as the Gargano, developed their unique fauna after occasional contacts with continental plates, notably during the so-called Messinian salinity crisis some 5.6–5.3 Myr BP (Azzaroli & Guazzone, 1980). During the Pleistocene, most Mediterranean islands developed unique unbalanced assemblages of mammals, including dwarf elephants and hippos capable of reaching them by swimming even in the absence of land connections. Fossil records of these unique faunas have been found in all large islands (Corsica and Sardinia, Sicily, Crete, Cyprus) and even in smaller ones (Pianosa, Capri, several Aegean islands, etc.) (Kotsakis, 1990; Palombo, 1996).

The Corsico-Sardinian island complex is the largest in the Mediterranean and the nearest to the mainland. When elephants and deer colonized the Corsico-Sardinian island complex during Early Pleistocene, they possibly caused the extinction of endemic large mammals such as *Nesogoral* (Schüle, 1993). Before the Holocene arrival of man, all the large-sized species were extinct in Corsica, while the deer *Praemegaceros* was still present on Sardinia (Vigne, Bailon & Cuisin, 1997). Orthodox theory does not recognize any role for humans in this extinction process, and climatic changes in the upper Pleistocene are considered the major factors in the extinction of many island species, just preceding any human invasions. This is contested by Schüle (1993) who argues instead for a human role in the disappearance of Pleistocene large mammals prior to the Neolithic. According to him, there is increasing evidence of a role of humans in the extermination of the larger mammal species on the Corso-Sardinia massif.

Evidence of human colonization before the Neolithic, although not definitive, is increasingly recorded in several Mediterranean islands. Furthermore, the survival of all Pleistocene small mammals, reptiles and amphibians in Corsica (Vigne *et al*., 1997) seems strong evidence

for a human, not climatic, role in the extinction of the island's larger endemic mammals, which probably lacked anti-predator behaviours. Whatever the exact reason, it is easy to appreciate that this Pleistocene mammal fauna was characterized by a high degree of endemism compared with present day continental faunas.

Although it is unclear when exactly hominids arrived on Sardinia and Corsica (cf. Spoor & Sondaar, 1986; but see also Costa *et al*., 2003), it is a fact that the Late Pleistocene mammalian fauna was very poor, unbalanced and highly differentiated (Vigne, 1992). It comprised two members of the insectivore genus *Nesionites* (*corsicanus* and *similes*) (Reumer, 1995), the canid *Cynotherium sardous*, the otter *Cyrnaonyx majori* and possibly *Nesolutra ichnusae* and *Megalenhydris barbaricina*, the lagomorph *Prolagus sardous*, a murine *Rhagamys orthodon*, and an arvicoline *Tyrrhenicola henseli*, and a deer of the genus *Praemegaceros* (Vigne, 1992). The largest species went extinct soon after *Homo sapiens* invasion. The four smaller species (*Nesionites*, *Prolagus* and *Tyrrhenicola*) manage to survive for at least 8000 years. Archaeozoological data show that around the IX-VIII Millennium BC, large mammals were not part of the diet of human groups in Corsica and *Prolagus* represented their main prey (Vigne & Desse-Berset, 1995).

The extinction of small-sized endemic mammals during the Roman period (after the arrival of *Rattus rattus*) seems correlated with a major increase in agriculture and, thus, deforestation (Vigne & Valladas, 1996). There is evidence that on Cyprus, early men hunted the last pygmy hippos and pigmy elephants of the Mediterranean to extinction around 10 000 BC (Simmons, 1999), though this is disputed by other authors (Vigne, 1996). Current evidence concerning the pre-neolithic mammal fauna of Crete shows that many species (e.g. *Candiacervus* sp., *Elephas creuzburgi*, *Lutrogale cretensis*) went extinct long before the beginning of Holocene (Reese, 1996; Vigne, 1999). On the Balearic Islands, the Messinian-Event relict *Myotragus balearicus* survived thanks to absence of human colonization until the Early Holocene. It has been proposed it was possibly domesticated or at least managed, until the Bronze or Iron ages, but this hypothesis has been recently rejected for lack of empirical evidence (Ramis & Bover, 2001).

The questionable dating of fossil remains, such as those attributed to *Sus scrofa meridionalis* and *Vulpes vulpes* of the Late Pleistocene of Sardinia (Vigne, 1990), contributed to the ambiguity concerning the origin of these island mammals, which were evidently dated older than they really are. Archaeo-zoological research is providing a wealth of data concerning the chronology of species colonizing islands thanks to human transport. In Corsica, the first immigrants observed among mammals, around 7000 BP, are the fox *Vulpes vulpes* and, among the domestic species, *Sus scrofa*, *Capra hircus* and *Ovis aries*. The domestic cat is only documented at the beginning of the Classical Antiquity about 2000 years ago, and there is no doubt these animals are the ancestors of current wild cats of Corsica and Sardinia; see Vigne (1992) for a synthesis on the subject.

Zoogeographical evidence

Biogeographical analysis can offer a further insight on the role of humans in the distribution of the present day mammal fauna. The distribution of terrestrial mammals, in particular, can be disturbed by human intervention, further confounding the full understanding of zoogeographical affinities of regions such as North Africa. Given proof of such activities on islands, it is likely that translocation of mammal species occurred also between continental lands. Examples of the human intervention in the distribution of mammals in the continental Mediterranean Region are illustrated by Dobson (1998): widely accepted introductions are those of the genet *Genetta genetta*, the Egyptian mongoose *Herpestes ichneumon*, the Algerian

hedgehog *Atelerix algirus* and the barbary macaque *Macaca sylvanus* in the Iberian Peninsula; likewise the introduction of the rabbit *Oryctolagus cuniculus* and the deer *Cervus elaphus* to the Maghreb.

Although several equivocal cases exist – e.g. *Ursus arctos* in North Africa or *Hystrix cristata* in Italy (Amori & Angelici, 1992; Hamdine, Thévenot & Michaux, 1998), there is enough evidence to highlight the role of humans as active or passive introducers of new faunistic elements to both mainland and islands areas of the Mediterranean. The presence of two different hare species, *Lepus corsicanus* in Corsica and *Lepus mediterraneus* in Sardinia, is further evidence of the importance of human historical factors in explaining the present island faunas. Similarly, most of the terrestrial mammals presently found on Cyprus are of Levantine and not Anatolian origin, as would be more logical on geographical grounds (Masseti, 1998). Contrary to non-volant mammals, bats seem to provide more sound biogeographical data than usually thought. Even though bats have been generally considered better dispersers, studies of the phylogenetic structure of bats of the genus *Myotis* in the Iberian Peninsula and Morocco show that the Strait of Gibraltar is sufficient to divide two sibling species of bats (Castella *et al*., 2000), thus highlighting the importance of overlooked zoogeographical barriers, not only for non-volant mammals, but even for Chiroptera.

Genetic and biomolecular evidence

Unequivocal confirmation of the recent origin of some islands' populations and in some instances of their paraphyly – come from biochemical and biomolecular studies. Frati *et al*. (1997) distinguish three source lineages for the Sardinian *Vulpes vulpes*, the main one originating from the Balkans and the other two from the Iberian peninsula and Italy, respectively. Sequences of the cytochrome b mitochondrial DNA gene show the recent origin of three species of Mediterranean spiny mouse, and their close relatedness to *Acomys cahirinus* from Egypt (Barome *et al*., 2001). According to mitochondrial DNA data, the Mediterranean mouflon shares a common ancestor with domestic sheep, probably as result of its origin from former domestic stock (Hiendleder *et al*., 1998). The same pattern was evidenced by similar studies on the genus *Capra*, which show that the haplotype of the Cretan wild goat is identical to that of the domestic goat (Manceau *et al*., 1999a). Although morphologically well differentiated and characterized by an increase in body size, the Elba Island wood mouse *Apodemus sylvaticus* is genetically similar to the Italian population (Filippucci, 1992). The anthropogenic origins of *Apodemus sylvaticus* populations in Corsica, Sardinia and Elba has been confirmed by mtDNA restriction patterns (Michaux, Libois & Fons, 1996).

The rapid consequences of adapting to an insular habitat for small populations, the so–called island syndrome, including changes in body size, is a well-known phenomenon whose causes and exact mechanisms are still controversial (Lomolino, 1985; Marquet & Taper, 1998). The general pattern, however, is that large species become dwarfed whereas small mammals evolve larger body size, making this single character alone of limited taxonomic utility (Berry, 1989). Considering that many mammals have also undergone spectacular chromosome evolution in the Mediterranean region, for instance *Eliomys* (Filippucci & Capanna, 1996), it is useful to note that chromosomal and mtDNA evolution appear to be largely independent processes (Taberlet, Fumagalli & Hausser, 1994). Chromosome polymorphism may have evolved very recently, as the occurrence of 32 different karyotypes in the domestic mouse in a small area of the Alps shows (Hauffe, Pialek & Searle, 2000). It is therefore of limited use to identify units worthy of conservation.

DO ANY PLEISTOCENE ISLAND ENDEMICS STILL SURVIVE?

Recent genetic and morphometric analyses show that only a few endemic terrestrial mammals still survive on the Mediterranean islands, and that these can be essentially restricted to two species of shrews (Blondel & Vigne, 1993; Blondel & Aronson, 1999) and possibly one mouse (Bonhomme *et al*., 2004). These are the Sicilian white-toothed shrew, *Crocidura sicula* distributed on Sicily, Levanzo, Favignana, Marettimo, Ustica and Gozo, the Cretan white-toothed shrew, *Crocidura zimmermanni* endemic to Crete (Sarà, 1998) and, with some reservations owing to its very recent discovery, the Cyprus mouse *Mus cypriacus* (Bonhomme *et al*., 2004). In Macaronesia, one further endemic shrew escaped extinction; *Crocidura canariensis* (Hutterer, Maddalena & Molina, 1992), while the taxon *osorio* has been recently shown to be conspecific with *Crocidura russula* (Cosson *et al*., 2005). The same fate has overtaken *Crocidura cossyrensis* of Pantelleria, now considered conspecific with the Tunisian and Sardinian populations (Cosson *et al*., 2005).

A number of other endemic species are often reported, based on classical taxonomic and karyotypic studies. However, when genetic and molecular data became available, as in the case of *Acomys* on Crete and Cyprus, specific status seems clearly unwarranted (Barome *et al*., 2001). Otherwise, weak differentiation, as is expected by Holocene invaders, leads to quite contrasting taxonomies. For instance, *Gerbillus (Dipodillus) zakariai* is reported as endemic on the Kerkennah archipelago, Tunisia by Sarà (1998) but it is synonymized with mainland *G. simoni* by Musser & Carleton (1993). While most of the mammals on oceanic islands have been heavily altered by humans, 'continental' islands, such as Sicily and Euboea, may still possess genetically differentiated populations whose particular phylogenetic relationships have only recently begun to be investigated. Both of these islands were certainly connected to the continent quite recently, as shown by their mammal fauna, but could have been separated enough to maintain distinct populations from the nearest mainland (Bonfiglio *et al*., 2002). In a study of the genetic structure of southern European fox *Vulpes vulpes*, Frati *et al*. (1997) discovered that the Sicilian population is allied to the Balkan/Iberian fox and not to the Italian populations. Ironically, while the anthropochorous Sardinian population received formal taxonomic recognition as *V. vulpes ichnusae*, the Sicilian population has never been taxonomically described. Even the wild cat of Sicily may warrant the status of a conservation unit, given its genetic distinctiveness from the peninsular population (Randi & Ragni, 1991; Randi, personal communication), yet this conservation priority has been totally obscured by the presence of the introduced – but taxonomically recognized – feral cats of Sardinia.

Bats represent the only island mammal group which has not been heavily manipulated by man. Recent research emphasizes the susceptibility of bats to geographical barriers, even a narrow tract of sea (Castella *et al*., 2000), suggesting the need for detailed research on the larger and more isolated Mediterranean islands. The recent discovery of a new *Plecotus* species on Sardinia (Mucedda *et al*., 2002) confirms the likelihood of divergent populations on these islands.

INTERNATIONAL LEGISLATION

International laws protecting Mediterranean terrestrial mammals are mainly limited to the European Continent and mainly stem from the Bern Convention. The Bern Convention formed the foundation for the Habitats Directive (EC Directive 92/43) the aim of which is the designation of special areas for the conservation of species and habitats of 'Community Interest'. Most of the listed taxa among terrestrial and volant mammals are at the species level. Among the most protected species, several, such as *Cricetus cricetus*, *Sciurus anomalus*

and *Sicista betulina* occur only marginally in Europe, sometimes, as is surely the case with *Atelerix algirus*, due to human introduction – and are clearly not globally threatened. With respect to island populations, other than *Cervus elaphus corsicanus*, *Capra aegagrus* and *Ovis ammon musimon* (the latter two with the citation 'only natural populations'), it is important to note the inclusion of the Cretan lesser white-toothed shrew *Crocidura suaveolens caneae* in Annex II of the Directive, while the palaeoendemic Cretan white-toothed shrew *C. zimmermanni* is not listed, although it is considered Vulnerable by the IUCN (2002).

It appears that a profound revision of the Habitats Directive lists is needed (Bouchet, Falkner & Seddon, 1999). Among anthropochorous taxa, current European legislation only provides protection to a few taxa, neglecting others that are equally interesting and that are declining, such as the Sardinian dormouse *Glis glis meloni* and the wild cat of Crete *Felis lybica cretensis*. To resolve such incongruence, we suggest that all known anthropochorous taxa should be excluded from international and possibly national protective legislation. This simple measure should redirect attention towards the few extant palaeoendemic insular mammals and provide an unequivocal order of priority when conflicts arise, for instance, between an endemic plant and an introduced mammal. Another way to reduce the importance of palaeointroduced mammals is to reject the application to them of subspecific names, in the absence of any clear-cut criteria, in national checklists, red lists, faunas, etc.

Legal obligations to reintroduce species to their former range, as evidenced in some international and European treaties, may give rise to several problems on islands, mainly due to the lack of definition of native species (Rees, 2001). For instance, the introduction of wild boar *Sus scrofa* to Cyprus was seen by hunters as fulfilling an obligation under international treaties to encourage reintroduction of native species (Hadjisterkotis, 2000). Wild boar never occurred naturally on Cyprus, nor other isolated Mediterranean islands, nevertheless this and other game animals, such as the mouflon, continue to be introduced to Mediterranean oceanic islands, and even (or especially) in protected areas because they are considered typical of the Region. Thus, we need to adopt a restrictive definition of native in conservation lists and environmental legislation (Gippoliti & Amori, 2002a,b). Targets for reintroduction programmes are usually large, charismatic, game mammals or predators, a fact mirroring a bias of interest in the conservation literature (Amori & Gippoliti, 2000).

BIODIVERSITY OF MEDITERRANEAN MAMMALS

As far as is known today, about one-fourth of the mammalian species found in the Mediterranean region have been described as endemic to the area (Cheylan, 1991), including very peculiar elements, such as *Macaca sylvanus*, a taxon clearly separated from the other members of the genus living in Asia (Deinard & Smith, 2001), and the monotypic *Oryctolagus cuniculus* (Branco, Ferrand & Monnerot, 2000). It is likely that continued refinement of systematics in the region will result in an appreciable increase in the number of species and the rate of endemism in the region.

Lack of appreciation of palaeoecological and historical events by the conservation community has resulted in skewing the policy interest, legal enhancement and financial resources to favour the protection of a small number of barely diagnosable taxa of recent anthropochorous origin that are presently restricted to well-determined geographical areas (i.e. island endemics). Such island endemics may originate from domestic stock or from a mixture of different stocks (Barome *et al*., 2001; Kahila Bar-Gal *et al*., 2002). Their conservation value is therefore low compared with native taxa, unless they are the only descendants of now extinct continental populations (Gippoliti & Amori, 2002a). This may be the case for the *Cervus elaphus* of North Africa and Sardinia, forming a distinct clade in a phylogenetic tree

based on analysis of variation in cytochrome b (Pitra *et al*., 2004). Further studies may possibly elucidate the exact geographical origin of this clade, helping to generate a meaningful conservation strategy beyond the present human-mediated distribution.

Furthermore, systematic studies of ancient introduced taxa may obscure real diversity. This is the case in the wild cat *Felis silvestris* group. According to a genetic study (Randi & Ragni, 1991), only one polytypic species should be recognized, including *silvestris*, *lybica* and domestic *catus*. However, their sample of *libyca* originated from Sardinia; this is an introduced population of Near East and domestic origin, traditionally allocated to the African form but which may constitute a poor representative for sub-Saharan wild cats, as shown by more recent research (Wiseman, O'Ryan & Harley, 2000).

Efforts to maintain mammalian diversity in the Mediterranean Basin must recognize the exceptional value of the truly autochthonous taxa that have escaped former extinction events in the Mediterranean islands (Table 1). Southern Europe is becoming recognized more and more as an important centre of endemism in its own right, rather than just a refuge source for northwards colonization during the postglacial period (Bilton *et al*., 1998; Hewitt, 1999). While great efforts have been directed towards conserving some insular forms, generally game or charismatic animals such as the mouflon or the wild goat, palaeoendemic insular taxa like *Crocidura zimmermanni* may suffer heavy competition from the introduced *Crocidura suaveolens* (Sarà, 1998). Even quite distinctive mainland populations have disappeared recently, such as *Capra pyrenaica pyrenaica* in Spain (Péres *et al*., 2002) whose Evolutionary Significant Unit (ESU) status has been confirmed by biomolecular investigations (Manceau *et al*., 1999b). The situation of the wild boar *Sus scrofa* may be a paradigm of the consequences of overlooking continental forms. Although the central Italian population was described as a distinct subspecies, *majori*, in 1927, it has been generally overlooked in subsequent revisions, which instead accepted as valid the Sardinian subspecies *meridionalis* (Apollonio, Randi & Toso, 1988; Genov, 1999; see also Boitani, Lovari & Vigna-Taglianti, 2003). Since the Second World War, continental Italy has been subject to several introductions of wild boars from Eastern Europe for hunting purposes, and autochthonous pure populations only survive in a few areas, especially enclosed ones such as the Castelporziano Presidential Estate Reserve near Rome. In recent years, a number of studies aimed at clarifying the history of domestication of pigs revealed that the original Italian population represents one of the three divergent *Sus scrofa* lineages found worldwide (Kias & Andersson, 2001; Larson *et al*., 2005),

Table 1. List of Mediterranean island endemic mammal taxa and populations, and taxa for which more taxonomic research is required

Island/s	Endemic taxa	Taxa that need more research
Sicily	*Crocidura sicula* *Erinaceus europaeus consolei* *Microtus savii nebrodensis* *Apodemus sylvaticus dichrurus* *Lepus corsicanus* ssp.	*Felis silvestris*
Corsica/Sardinia	*Plecotus sardus*	Chiroptera Generad et spp.
Crete	*Crocidura zimmermanni*	Chiroptera Generad et spp.
Cyprus	*Mus cypriacus*	*Roussetus aegyptiacus*
Balearic		Chiroptera Generad et spp.
Euboea		*Chionomys nivalis*
Corfu		*Talpa stankovici*
Limnos		*Nannospalax leucodon insularis*

conferring a high conservation value to the few pure surviving populations of this disputed taxon.

While a few Mediterranean endemics such as *Lynx pardinus* and *Rupicapra pyrenaica* are now recognized both taxonomically and as international conservation priorities (Beltrán, Rice & Honeycutt, 1996; Pérez, Albornoz & Domínguez, 2002), it is increasingly important that research be directed to identify remaining divergent populations scattered around the complex geography of the Mediterranean Basin, and to reassess their conservation status. Oriani (2000) has recently hypothesized that a population referable to *Lynx pardinus* survives in the Middle East. This would be in agreement with the current paradigm of southern Europe as a centre of endemism, as suggested by recent research (Bilton *et al*., 1998; Taberlet *et al*., 1998; Hewitt, 1999), rather than just a source for northwards re-colonizations during interglacials.

Similarly, more complex situations are becoming evident on all the major land masses around the Mediterranean. Phylogeographical research on *Crocidura russula* indicates the existence of two clearly distinguished lineages within the Maghreb (Cosson *et al*., 2005). Even the recognition of specific distinctiveness of sub-Saharan *Lemniscomys zebra* from *L. barbarus* of the narrow coastal strip of north-west Africa (Carleton & Van der Straeten, 1997) seems to confirm the distinctiveness of the so-recognized Barbarian zoogeographical province. Genetic and biometric studies have also highlighted the distinctiveness of the small mammal fauna in the Near East (Filippucci, Simson & Nevo, 1989; Filippucci *et al*., 1991; Filippucci *et al*., 1995). It is thus highly likely that further molecular studies will identify or confirm the presence of several distinct phylogeographical units whose existence has been obscured by the traditional morphologically based taxonomy (cf. Cook & MacDonald, 2001). This has serious conservation implications, because classical species lists are generally the only tool available to prioritize important areas, in the absence of phylogeographical data.

CONCLUSIONS

On Mediterranean islands, the importance given to large mammals is a further threat to the status of the majority of biodiversity in the region. The role of introduced mammals to sustain populations of valuable species such as birds of prey on islands (Seguin *et al*., 2001) has been somewhat emphasized. However, the often unrecognized homogenization effects on biological diversity of mammalian introductions to the historically mammal-free Balearic Islands of Eivissa and Formentera have recently been highlighted by Palmer *et al*. (1999). The negative effects of exotic herbivores for native mammals, through the so-called hyperpredation effect, has been recently demonstrated in a Californian island (Roemer, Donlan & Courchamp, 2002). Furthermore, few details are available about the effects of herbivores on the native vegetation or of the high density of carnivore predators on the native biocoenosis. There is scattered evidence, however, of the serious negative impact of presumed native ungulates on the vegetation of Mediterranean islands, particularly when protected areas are declared and hunting is totally prohibited (Fabbri, 1966; Greuter, 1979; Gippoliti & Amori, 2004). It should be remembered that the uniqueness of the Mediterranean Region is due mainly to the richness in species and the high rate of endemicity found in vascular plants (25 000 species according to Delanoë, de Montmollin & Olivier, 1996). It appears that, paradoxically, some conservation measures such as declaring reserves (for ungulates), are seriously damaging the most valuable part of Mediterranean biodiversity and call for an urgent infusion of palaeoecological and evolutionary data into conservation politics.

It should be emphasized, however, that we do not deny any value to anthropochorous taxa, for which we call for a complete conservation assessment (Gippoliti & Amori, 2002a). These

populations have an intrinsic interest for their unique history (Groves, 1989), their genetic heritage and, potentially, for the ecological role they could play in already very disturbed ecosystems or as the functional ecological substitute for extinct species. Yet it is crucial, they are considered only as a fraction and not as the main target of biodiversity conservation goals. Meanwhile, there is increasing evidence from molecular phylogenetic studies that current taxonomy and legislation conspire in overlooking mammal distinctiveness in the different continental regions of the Mediterranean Basin. Consequences for biodiversity conservation can be serious if interest and funds are not redirected from island mammals towards continental populations. If modern society is seriously engaged in biodiversity conservation, a series of developments in conservation politics need to be undertaken. First, an international convention for the conservation of Mediterranean biodiversity needs to be created, to assure adequate funding for research and conservation of distinctive populations in the lesser known countries of North Africa and the Middle East. Second, systematic studies should be encouraged because a detailed knowledge of population phylogenies is fundamental for assessing conservation units and priorities. The discoveries of two new endemic species of mammals in the Mediterranean islands (*Plecotus sardus* and *Mus cypriacus*) in the last 4 years highlight how scarce and fragmentary our knowledge still is. Finally, the results of such researches need to be taken into account by taxonomists and promptly included in national and international legislation.

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