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Marine Biogeography of the Mediterranean Sea: patterns and dynamics of biodiversity

Mediterranean Island mammals: are they a priority for biodiversity conservation?

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SUMMARY

The importance of taxonomy in biological conservation is now well established. However, the risk involved in assigning specific or subspecific status to feral mammals or mammals introduced in the Mediterranean Islands ancient time, has been generally overlooked. In fact, these 'antropochorous taxa', especially ungulates such as 'wild' goats and 'wild' sheep, have became the focus of many national and international conservation activities because of their high aesthetic, symbolic and hunting value. This, however, has often lead to a misallocation of conservation resources thereby indirectly damaging the future prospects for the few true surviving insular paleoendemic mammals such as the Cretan and Sicilian shrews *Crocidura zimmermanni* and *Crocidura sicula*, respectively. Conservation policies simply based on protection of anthropocorous mammals – or of birds of prey whose populations depend on such insular mammals – need to be carefully re-assessed. Actually, there is scattered evidence that this approach represents a further threat to the whole Mediterranean island biodiversity. Great caution is especially needed in small, protected, 'ocean-like' islands where mammals – especially ungulates – are not hunted and endemism rate is usually high. Here, the growth of ungulate populations can have disastrous effects on biodiversity throughout both disappearance of several endemic plants which lack defence from grazing, and a likely cascade effect on invertebrate communities. Nowadays, knowledge of each island palaeoecology is essential to assess the best management options for antrophocorous mammals in the interest of Mediterranean biodiversity conservation.

INTRODUCTION

The importance of taxonomy in the conservation assessments has often been emphasised in the last years (McNeely, 2002). It is obviously not possible to protect what is not believed to exist and it is not recognised by taxonomy. This is the case of the tuatara, *Sphenodon* spp., as revealed by a well-known study on its systematic (Daugherty et al., 1990). On the other hand, the opposite problem also exists. A formal taxonomic recognition could justify considerable conservation

interest for a geographic segment of a species at the expense of other populations. For instance, the green turtle of Eastern Pacific has often been recognised as a distinct, endangered species, *Chelonia agassizi*, with clear conservation implications, while molecular data support only subspecific status at best (Karl and Bowen, 1999). In the present paper, we discuss similar problems concerning the conservation of Mediterranean islands mammals.

ANTROPOCHOROUS MAMMAL TAXA IN THE MEDITERRANEAN ISLANDS

Owing to sensitivity of islands to biological invasions, insular biodiversity loss is one of the world major environmental crisis (Vitousek, 1988). Furthermore, a historical 'typological' thinking in taxonomy often leads zoologists to classify each insular population as a different species or subspecies (Berry, 1989). Acceptances of such typological taxonomy obviously lead to a high conservation relevance for these insular taxa. This procedure seems particularly incorrected for Mediterranean mammals. Here, a long history of human activities has had strong effects on the island environments particularly on the endemic mammals (Blondel and Vigne, 1993). With the arrival of humans in the Neolithic, an almost complete turn over of the mammalian fauna of the islands is observed (Cheylan, 1991; Vigne, 1992; Schüle, 1993; Masseti, 1998). Most of the endemic species, especially the largest ones, became immediately extinct while a few of the smaller species, such as *Prolalagus sardus* in Sardinia, survived until Roman times (Vigne et al., 1997). Most of present insular mammals have a clear relationship with continental taxa. In fact, a slight morphological differentiation in insular population, such as a tendency to nanism or gigantism, can evolve in a relatively short time (Lister, 1989), without an appreciable genetic differentiation (Filippucci, 1992). Even with a change in the chromosomal number through a Robertsonian translocation, a character, which is often assumed of great taxonomic relevance, can originate in a brief period of time (Britton-Davidian et al., 2000).

Mt DNA analysis confirms the recent origin of insular populations and, often, their paraphily.

Frati et al. (1997) found evidence that the Sardinian fox *Vulpes vulpes ichnusae* was imported at least twice from different source populations and similar results were reached by Barome et al. (2001) for the Cretan spiny mouse *Acomys minous*. A particular challenge to taxonomy is offered by the systematic position of mammals which were introduced at a primitive stage of domestication in ancient times. Molecular studies confirm archaeozoological findings (Groves, 1989; Vigne, 1994) that suggest that wild goats and muflons of Mediterranean islands are feral populations of ancient domestic stocks (Hiendleder et al., 1998; Kahila Bar-Gal et al., 2002). Thus, also in agreement with the proposal of Gentry et al.

(1996), such taxa should be included in the respective domestic species (*Capra hircus, Ovis aries*) and not as subspecies of the wild taxa (*Capra aegagrus, Ovis gmelini*). Similar conclusions have been reached for insular populations of rabbit (Hardy et al., 1995). It should be stressed that antropochorous mammal taxa are not exclusive of islands, but there are many examples especially in the Iberian Peninsula and Maghreb (Dobson, 1998). Furthermore, ancient introductions have also interested other taxonomic groups such as reptiles (Paulo et al., 2002), a fact which is further confirmed by the synonymy of the subspecies *Vipera aspis montecristi*, of Montecristo Island, with *Vipera aspis hugyi* of southern Italy (Zuffi and Bonnet, 1999)

CONSERVATION IMPLICATIONS

What kind of conservation priority do insular anthropochorous mammals deserve in the Mediterranean area? This question should be considered in the framework of a holistic approach to biodiversity conservation in the region. The Mediterranean Basin is one of the 25 world biodiversity hotspots given the richness of its flora – one tenth of world plant species in 1,5% of Earth surface – and the high endemism rate of about 50% (Blondel and Aronson, 1999; Myers et al., 2000). Islands hold a high percentage of endemic plants (Delanoë et al., 1996) and insects (Balletto and Casale, 1991). Among vertebrates, amphibians, although limited in the region by their biology, show the presence of several ancient taxa which have great biogeographical relevance, such as *Hydromantes* – the only extra-American Plaetodonthidae – and *Euproctus* (Blondel and Aronson, 1999). Nevertheless, mammals, especially those of large size, tend to receive a disproportionate attention from both the laymen and the scientists because of their hunting, symbolic and cultural value (Amori and Gippoliti, 2000). For instance, the mouflon and the Sardinian red deer (*Cervus elaphus corsicanus*) have been used in a map to illustrate the biodiversity of the Mediterranean hotspot (National Geographic, 1999). This is why it has been suggested to delete antropochorous taxa from national and international Red Lists (Gippoliti and Amori, 2002). Some of them, however, have interesting biological peculiarities, such as the Sardinian garden dormouse *Eliomys quercinus*, the only member of the *lusitanicus* complex having 2n = 50 (Filippucci and Capanna, 1996). Our proposal only intends to give the right conservation weight to the truly endemic insular elements instead of favouring the results of recent, human-mediated experiments. It is also our aim to discourage further introductions of 'rare' Mediterranean mammals, in particular ungulates, on other islands, especially protected ones, for 'conservation' reasons. Actually, the increase of ungulates densities, owing to island protected status, should be carefully monitored in order to avoid heavy pressures on biocoenosis and loss of biodiversity. Management strategy should consider the paleoecological aspects of each island,

particularly the presence of native mammals in the Pleistocene. For instance, in the Sardo-Corso Massif, paleo-introduced ungulates can have a positive role in the ecosystem through a moderate vegetation disturbance (Verdù et al., 2000). On the contrary, in oceanic islands like Formentera and Zannone, which never had autochthonous ungulates, endemic plants could suffer from the introduction of ungulates because of the absence of any adaptation to protect them from grazing (Bowen and Van Vuren, 1997). While the impact of species such as *Rattus rattus* on colonial nesting sea birds is well known (Thibault, 1995), the effects on other components of island biodiversity is generally less appreciated. In the Balearic islands, Mallorca and Minorca, introduced carnivores caused the extinction of the endemic lizard *Podarcis pityusensis*, and, as consequence, causing a change in seed dispersion of the endemic plant *Cneorum triccon* (Riera et al., 2002). Comparing the tenebrionid fauna of 51 islets of the Balearic, Palmer and Pons (1996) found that the presence of rats, while increasing the extinction rate of endemic tenebrionid species, does not alter the total number of species due to replacement by non-endemic, synantropic species.

Abundance of 'exotic' preys on islands has been proved to cause the possible extinction of endemic taxa. In a Californian island, the presence of feral pigs lead to the establishment of golden eagles and the reduction of an endemic fox preyed upon by the eagles (Roemer et al., 2002). This case offers a model to explain the almost total extinction of small palaeoendemic mammals in the Mediterranean islands – the only exceptions being two species of shrews of the genus *Crocidura*, usually not considered edible by mammalian predators. On the other hand, modern insular mammals had a key role in maintaining population of charismatic species such as birds of prey (see for example Bonelli's eagle, *Hieraaetus fasciatus*, Arroyo and Ferreiro, 2001). This may create a conflict between protection of birds of prey – another group of great interest for conservationists – and the safeguard of neglected groups such as invertebrates or plants.

Less than 20 years ago, a group of mammalogists discussing the status of Mediterranean mammals, identified the monk seal, the Corsican red deer, the fallow deer and the otter, as four conservation priorities for insular mammals (Cheylan, 1988). Nowadays, more data and the awareness of the need to direct our efforts toward truly insular endemic species, allow us to compile a more rigorous set of priorities including:

a) paleoendemic taxa, such as the monk seal and the Cretan white-toothed shrew *Crocidura zimmermanni*;
b) island populations whose present distribution is unlikely to have been mediated by humans, such as *Talpa stankovici* on Corfu and the snow vole *Chionomys nivalis* on Euboea;
c) bats, especially populations of Crete and of the Sardo-Corso Massif.

CONCLUSION

The taxonomic uniqueness of Mediterranean insular mammals as compared to the continental European fauna, conspired to give them a high conservation relevance. Some of these are 'anthropochorous' taxa and are listed in national and international conservation lists, such as the IUCN Red List, and are protected by international treaty such as the Bern Convention (Tab. I). In Italy, for instance, five of such taxa are included among the 22 most threatened mammals of the country (Bulgarini et al., 1998). Being unlikely that such taxa could be defined as ESU's (Evolutionary Significant Units) (Crandall et al., 2000; Fraser and Bernatchez, 2001), they should be lower ranked in the conservation agenda. It has been suggested to exclude 'antropochorous' taxa in national and international red lists (Gippoliti and Amori, 2002a), when considering the conservation status of true endemic taxa. Even at the national level, strategies should aim at protecting species internationally recognised as worthy of conservation priorities (Gippoliti and Amori, 2002b), especially in a biodiversity hotspot such as the Mediterranean Basin.

Tab. I - 'Endemic' taxa of the Mediterranean islands and their conservation status. Systematic sources: Amori et al., 1999; Corbet, 1978, 1984; Garcia-Perea and Gisbert, 1997; Krystufek and Vohralik, 2001; Sarà, 1998; Wilson and Reeder, 1993. Legislation status from: Bulgarini et al., 1998; IUCN, 2002; Spagnesi and Zambotti, 2001.

TAXON	ISLAND	IUCN (2002)	BERN CONVENTION	ITALIAN RED BOOK
INSECTIVORA				
Atelerix algirus girbaensis	Djerba			
Atelerix algirus vagans	Balearic			
Atelerix algirus fallax	Malta			
Hemiechinus auritus dorothea	Cyprus			
Erinaceus europaeus consolei	Sicily			
Erinaceus concolor nesiotes	Crete			
Erinaceus concolor rhodius	Rhodes, Lesbos, etc.			
Paraechinus aethiopicus blancalis	Djerba			
Suncus etruscus pachyurus	Sardinia			
Crocidura russula ibicensis	Ibiza			
Crocidura russula ichnusae[1]	Sardinia			
Crocidura suaveolens cyrnensis	Corsica			
Crocidura sicula	Sicily, Egadi, Malta			VU
Crocidura suaveolens canea	Corfu			
Crocidura suaveolens balearica	Minorca			
Crocidura suaveolens cypriae	Cyprus		II as *C. russula cypria*	
Crocidura suaveolens ariadne	Crete		II	
Crocidura zimmermanni	Crete	VU		
LAGOMORPHA				
Oryctolagus cuniculus huxley	Sicily, Sardinia			
Oryctolagus cuniculus cnossius	Crete			
Lepus capensis mediterraneus	Sardinia			VU
Lepus europaeus ghigii	Stampalia			
Lepus europaeus cyprius	Cyprus			
Lepus europaeus creticus	Crete			

Tab. I - continued

TAXON	ISLAND	IUCN (2002)	BERN CONVENTION	ITALIAN RED BOOK
Lepus europaeus rhodicus	Rhodes			
Lepus europaeus carpathous	Carpathos			
Lepus granatensis solisi	Mallorca			
RODENTIA				
Eliomys quercinus liparensis	Lipari			CR
Eliomys quercinus sardus	Sardinia			EN
Eliomys quercinus gymnesicus	Mallorca, Minorca			
Eliomys quercinus ophiusae	Formentera			
Glis glis melonii	Sardinia			VU
Glis glis argenteus	Crete			
Microtus savii nebrodensis	Sicily			
Gerbillus simoni zakiaria	Kerkennah			
Mus spretus parvus	Ibiza			
Apodemus sylvaticus eivissensis	Ibiza			
Apodemus sylvaticus frumentariae	Formentera			
Apodemus sylvaticus ilvanus	Elba			
Apodemus sylvaticus hermani	Pantelleria			
Apodemus sylvaticus creticus	Crete			
Apodemus sylvaticus krkensis	Krk			
Apodemus mystacinus rhodius	Rhodes, Crete, Carpathos			
Apodemus flavicollis krameri	Eubea			
Acomys cahirinus minous	Crete	VU		
Acomys cahirinus nesiotes	Cyprus	DD		
Nannospalax nehringi insularis	Limnos			
CARNIVORA				
Vulpes vulpes ichnusae	Sardinia			
Vulpes vulpes indutus	Cyprus			
Martes martes latinorum	Sardinia			
Martes martes minoricensis	Minorca			
Martes foina milleri	Rhodes			
Martes foina bunites	Crete			
Mustela nivalis corsicana	Corsica			
Mustela nivalis boccamela	Sardinia			
Meles meles arcalus	Rhodes			
Meles meles rhodius	Rhodes			
Genetta genetta isabelae	Ibiza	VU		
Genetta genetta balearica	Mallorca			
Felis libyca sarda	Sardinia		VU as *F. silvestris libyca*	
Felis libyca reyi	Corsica			
Felis libyca jordan	Mallorca			
Felis libyca cretensis	Crete			
ARTIODACTYLA				
Sus scrofa meridionalis	Sardinia		III	
Cervus elaphus corsicanus	Sardinia, Corsica	EN	II	EN
Ovis aries musimon	Sardinia	VU	III as *Ovis aries*	VU
Ovis aries ophion	Cyprus	EN	III as *Ovis aries*	
Capra hircus creticus	Crete	VU	II as *C. aegagrus*	

1) This taxon is now considered as a distinct lineage from *C. russula*. See Lo Brutto et al., 2004 (Heredity, 92: 527-533).

Therefore, it is time to reconcile biodiversity conservation with the overemphasis usually accorded to the protection of ungulates introduced on small islands. The populations of 'wild' goats in Montecristo and Dhia islands (Fabbri, 1966; Greuter, 1979) should be at least 'controlled'. More recently established populations such as the mouflons in the protected islands of Zannone, Marettimo, and Capraia should be eradicated. In the meantime, it should be put a stop to further introductions such as those of wild boar in Cyprus (Hadjisterkotis, 2000) and in several Italian islands (see contributions to Giusti, 1995).

Small islands are considered one of the conservation priorities in the Mediterranean region because of lack of anti-grazing adaptations in the endemic plants (Greuter, 2001). Furthermore, each of the major Mediterranean islands complex is considered a biodiversity sub-hotspot (Médail and Quézel, 1999). Logically, overgrazing may have serious consequences for other organisms too.

The great richness of coprophagous scarabeid beetles compared to plant-eaters ones found in the protected Asinara Island confirm the serious impact of domestic and 'wild' ungulates on vegetation (Carpaneto and Piattella, 1995).

It should be auspicial, however, a census of all antropochorous taxa and feral populations scattered in the Mediterranean Basin with the goal of protecting their unique genetic resources, if necessary with *ex situ* conservation programs as well. It should be emphasised that, while national and international laws protect many anthropochorous taxa, many others, such as the several hares subspecies of the Eastern Mediterranean islands (De Beaux, 1929), are completely overlooked by legislation.

Exclusion of these taxa from conservation lists appear justified if aiming at the preservation of the extreme biodiversity richness of the Mediterranean Basin. We also stress the need to educate the public opinion about the great threat represented by present biological invasions (see Andreotti et al., 2001; and Scalera, 2001 for a synthesis of vertebrate introductions in Italy). Without this exclusion, we risk that conservation measures, such as the establishment of reserve on islands, result in serious threats for the whole biodiversity.

Finally, if we want that our faunistic and biogeographic researches are considered in the planning of conservation politics, a greater collaboration between biogeographers and natural history museums, including botanical gardens, is essential to reach a wider audience.

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