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The Mouse, Endemic Rodents and Human Settlement in the Canary Islands

Jacques Michaux

Introduction: the Canary Islands and the aboriginal human population

The European navigators of the end of the medieval period who explored the western coast of Africa encountered the Canary Islands, which they found to be inhabited. To those inhabitants was given the name of Canarians, or Guanches. For the most part they were animal herders. But earlier seafarers, whether Muslim or Christian, who made short coastal voyages along the north-west coast of Africa, must certainly have known of, or even landed on, the archipelago (Figure 1). In fact, such an eventuality may be extended much further back in time, since sailors of ancient times were known to have sailed beyond the Pillars of Hercules and travelled both to the north and to the south of the Straits of Gibraltar. There is certain evidence of such contacts going back at least until the middle of the first millennium before the Common Era (see among other references Mederos Martín and Escribano Cobo, 2002).

The aboriginal Canarians came to occupy a group of islands close to the African mainland, characterized by a subtropical climate and a zonal vegetation structure responding to the relief of the area and the extent of its exposure to the trade winds. This civilization disappeared with the arrival of settlers from the Iberian peninsula, and the subsquent assimilation of their populations. Though this stage of their history is known through documentary evidence from the period, the origin of the Canarians on the other hand, as of their civilization, remains poorly understood. Such questions are the domain of a variety of specialist fields of research, ranging from linguistics to human genetics, and including various branches of archaeology. However, there are other possible avenues of investigation which may contribute to a better understanding of these first settlers of the Canary Islands.

The archipelago possessed an endemic fauna of land vertebrates (particularly lizards, rodents and an insectivore) which was effectively decimated, particularly in

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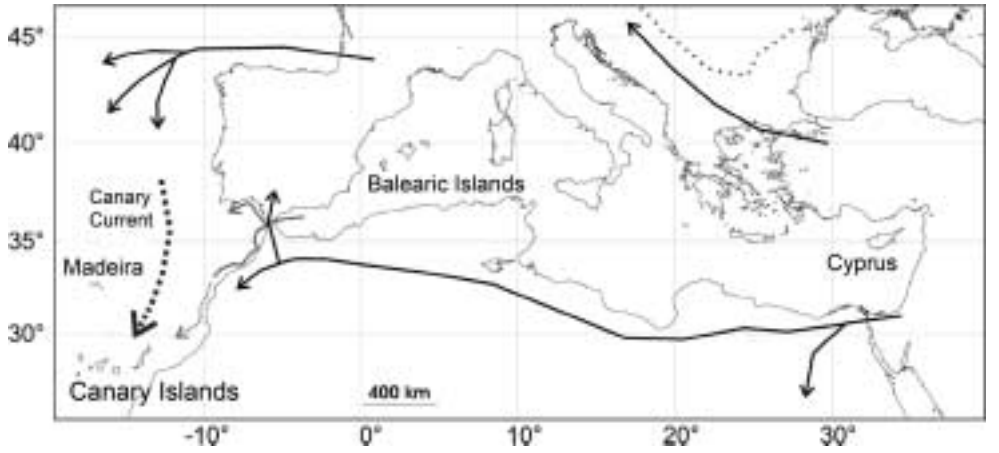

Figure 1. Map of the Mediterranean and the Atlantic littoral of North Africa. The solid black arrows indicate the westward expansion of *Mus musculus domesticus*; and the dotted lines trace the contact zone between *M. m. domesticus* and *M. m. musculus* (after Guénet and Bonhomme, 2003). A dashed-line arrow gives the direction of the Canaries Current, and shown in fine grey continuous or dotted lines is the extent of coastal seafaring beyond the Straits of Gibraltar, from Antiquity up to the 14th century.

the case of the very largest lizards as well as the rodents (Vogel et al., 2003). But the arrival of human beings would not only have eliminated the indigenous vertebrates, they had also brought with them domestic species, parasites and commensal species.

Extinction of endemic forms on the one hand and the establishment of commensal or domestic species on the other can indirectly assist in the study of human settlement. The original Canarians were, among other things, herders of livestock, and they had brought with them pigs, sheep, goats and dogs. Among the species that were also accidentally introduced, since they are commonly associated with humans, the mouse, which today occupies the whole of the archipelago, is one obvious example; but now it is found not only in dwellings but also in the open, because the benign nature of the Canaries subtropical climate permits this.

There is indeed evidence in archaeological deposits of the presence of mice. If it turns out that these remains belong to the commensal species, this would open up the possibility of contextualizing the history of the Guanches: did they or did they not bring this species with them? This article traces in broad outline the findings of certain current research projects, some involving the indigenous fauna of the Canary Islands (Bocherens et al., 2006) and others on the history of the Canaries mouse (Michaux et al., 2007).

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Recent history of endemic terrestrial mammals in the Canary Islands

The populating of islands formed *de novo*, such as volcanic islands, a circumstance applying to the Canary archipelago, results from accidental arrivals originating from a nearby continent or continents – and this regardless of the type of organism considered, be it plant or animal, given that all living things have the capacity for dispersal. Terrestrial forms thus are capable of crossing stretches of ocean. However, only some of the islands in the group harboured endemic mammals, these being three species of rodent and an insectivorous shrew. The rodents were members of the group of Old World rats and mice (Murinae). Two of these, labelled *Canariomys* (Crusafont and Petter, 1964; López Martínez and López Jurado, 1987), were of a fair size, weighing in the order of one kilogram, one being found on the island of Gran Canaria and the other on Tenerife. The third, of much smaller size, around 40g, was the *Malpaisomys* (Hutterer et al., 1988) from the eastern Canary Islands (Fuerteventura and Lanzarote). Only the shrew which lived alongside the *Malpaisomys* on these eastern islands still survives today.

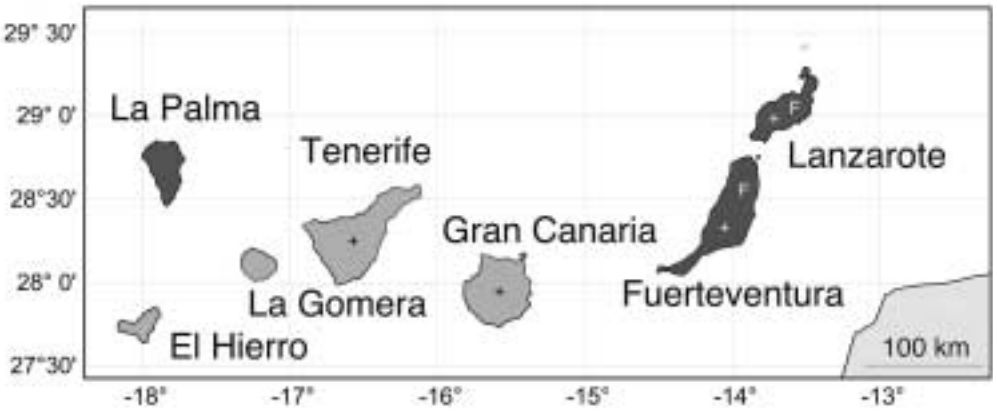

Figure 2. Map of the Canary archipelago. Crosses indicate the islands which were habitats for indigenous rodents, and F, the presence of fossil mouse populations. The relative darkness of the grey shading shows the degree of divergence between the insular mice in relation to reference populations in Europe and North Africa; the absence of a geographical gradation of this divergence is noteworthy (Michaux et al., 2007).

The small number of ^{14}C radio-isotopic datings as yet available in relation to these rodents shows that they were present at the beginning of the first millennium CE. It has been established that these rodents were contemporaneous with humans on Gran Canaria as well as on Fuerteventura, whereas on Tenerife, this conclusion can be deduced only from the dating obtained from endemic rat bones. These facts therefore accord with the early discovery of these rodent remains in archaeological layers,

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leading to the hypothesis that humans had a role in their extinction (Boye et al., 1992; Bocherens et al., 2006). A deterioration in the local climate (see Figure 4) between 4000 and 3000 years BCE, on the other hand (deMenocal et al., 2000), is considered unlikely to have had a particular effect on these rodents (Bocherens et al., 2006).

The Canary Islands mouse is the commensal form

The mouse present today throughout the whole archipelago is recognized as being *Mus musculus*, the grey mouse, a commensal species, whose sub-species *M. musculus domesticus* is found in western Europe and North Africa, among other places. Fossil remains collected on Fuerteventura had already been linked to *Mus musculus* (Carrascosa and López Martínez, 1988), but some of their characteristics showed a proximity with a wild species, the short-tailed mouse, *Mus spretus*, which is present in the Maghreb and in south-western Europe. It thus becomes necessary to demonstrate that the present-day Canaries mouse, as well as the one living there before, is in fact *Mus musculus*, and even more precisely the sub-species *Mus musculus domesticus*. For, indeed, wild species of mammals are also capable of crossing sea barriers. Just to take mice as an example, this is precisely what happened with the mouse *M. spretus*, which is present in the Balearic Islands (Menorca) in archaeological deposits of the Bronze Age (Morales et al., 1995) or , even more demonstrative, that of the new species recently discovered in Cyprus, *Mus cypriacus*. This latter species has probably been present on that island for several hundreds of thousands of years (Cucchi et al., 2006), thereby excluding any human involvement in its spread to that location. Nevertheless, the chances for a species commensal with humans to make a successful transition to an island are infinitely higher than those for a wild species.

Hence, the presence of *Mus musculus* in the Canary archipelago may well be taken as a sign of human contact with the islands, whereas that of *Mus spretus* is most probably the result of chance arrival without significance for an understanding of human settlement there. Though both species are currently found in North Africa, it is probable that only the second, *Mus spretus*, has been found in this region for several tens of millennia (Darviche et al., 2006). On the other hand, the length of time that *Mus musculus* has been present in the Maghreb during the Holocene remains to be precisely established. This situation should soon change, nevertheless, as may be anticipated from the work currently being undertaken on the Moroccan Holocene (Stoetzel et al., 2006: 121). The situation is different to the north of the Mediterranean. *Mus musculus domesticus* appeared in the Near East around 12,000 years ago (Auffray et al., 1988; Auffray et al., 1990), and reached western Europe during the last millennium BCE (Cucchi et al., 2005). Tracing the spread of the mouse in association with Neolithic societies has been achieved thanks to a reliable morphological determination of the fossil evidence at the specific or sub-specific levels (Cucchi, 2005). The paths by which these mice spread (Guénet and Bonhomme, 2003) are indicated for *M. musculus domesticus* in Figure 1.

The same approach has been applied for the Canary Islands mouse (Michaux et al., 2007). The research sample was constituted from populations of present-day mice from the archipelago and from fossil mice from the islands of Fuerteventura and

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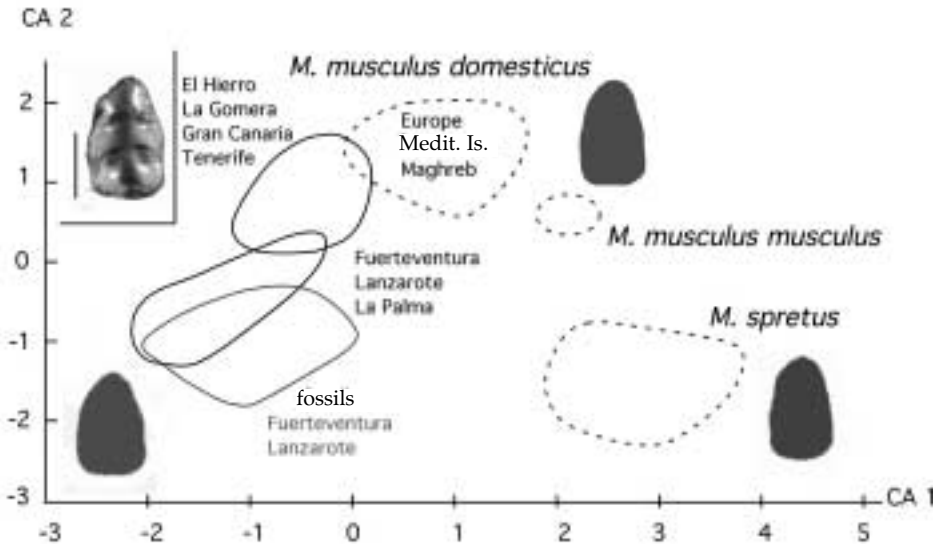

Figure 3. Variations in the contours of the first lower molars of Canary Islands mice (fine continuous outline) compared with reference populations of *Mus musculus domesticus*, *M. m. musculus* and *Mus spretus* (dotted outlines). The morphological space has also been subdivided according to geographical origin, with that of the fossil populations indicated in grey. An image of a first lower left molar is shown in the upper left box (the short vertical line represents 1mm, and the shaded silhouettes show the variation affecting the average molar contour (simplified from Michaux et al., 2007).

Lanzarote, to which were added European mice from several Mediterranean islands and from North Africa. These three latter groups bring together individuals whose genotypes have been determined, so permitting validation of the morphological observations. These three reference groups are divided between *Mus musculus* (the two sub-species *M. musculus domesticus* and *M. m. musculus*) as well as *Mus spretus*. The analysis (Figure 3) confirms the clear separation of the populations of *M. spretus* and *M. musculus*, since the present-day and fossil populations in the Canaries occupy a position close to that of continental populations and those of the Mediterranean islands of *M. musculus domesticus*. Finally, two distinct groupings of populations in the Canaries are apparent, the *M. m. domesticus* of the islands of El Hierro, La Gomera, Tenerife and Gran Canaria on the one hand, and those of Fuerteventura and Lanzarote, as well as of La Palma, on the other. Furthermore, the mice of Fuerteventura and Lanzarote, as well as of La Palma, differ more from the grey mice of the reference sample (those of western Europe and the Maghreb) than from those of the other islands. These results both establish that the populations of Canaries mice belong to the commensal form and, at the same time, emphasize their originality. This work, which reinforces the earlier study of the fossil mice of Fuerteventura (Carrascosa and López Martínez, 1988), provides evidence of a complex history,

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since the variation between the islands requires explaining. But as a commensal mouse could not have spread without the involuntary assistance of humans, studying it may bring new light to the questions of contact between the archipelago and the continent.

Humans, mice and the isolation of the Canary archipelago

The establishment of the mouse on the Canary archipelago took place over an interval of time which it is possible to define through the limits imposed by several dates. In order, these temporal markers are: (1) the date when the niche opportunity for species to develop a commensal relationship with Neolithic human societies was established; (2) the occupation of this niche by the mouse; (3) the settlement of Neolithic peoples on the Atlantic seaboard of Morocco; and, finally (4) very probably, the beginning of regular contacts between the Canary archipelago and the rest of the world. These latter became regular from the 15th century. The question of humans crossing sea barriers, whether by chance or not, is important, because it seems that this occurred very early with the grey mouse. Thus, in the eastern sector of the Mediterranean, humans brought the mouse to Cyprus in the late 9th or early 8th millennium BCE (Cucchi et al., 2002).

Archaeological data from the Canaries supports a human presence there from the middle of the first millennium BCE (Mederos Martín and Escribado Cobo, 2002). The mouse has been identified in archaeological strata on Gran Canaria (around the beginning of the Common Era) and on Fuerteventura (at the beginning of the Common Era). These two findings do not a priori raise any questions since the species had reached western Europe during the last millennium BCE, and one may presume a parallel westward advance to the south of the Mediterranean. On the other hand, a presence of the mouse on Fuenteventura going back to the 5th millennium BCE does raise some questions (Coello et al., 1999; Castillo-Ruiz et al., 2001). If such an age were to be confirmed for the mice of the Cueva del Llano site, where there is no archaeological stratum, it would be established that contacts had taken place even before the date by which the existence of decked ships has been demonstrated, a type of vessel known from the middle of the last millennium BCE (Pomey, 1997; Vigne and Cucchi, 2005). But the presence of the mouse on Cyprus illustrates that such early voyages really did occur. The settlement of Neolithic populations of animal herders along the African coast renders such early contact plausible, given that evidence has been found for an intensification of human settlement opposite the Canary Islands in the Tarfaya coastal basin from around 5000 years ago (Onrubia-Pintado, 1996). But in the absence both of an irrefutable proof of the age of the Cueva del Llano mouse, and of the confirmation of the presence, several millennia before the Common Era, of *Mus musculus domesticus* in the Maghreb, no definitive conclusion can be reached. Finally, one must also consider that humans may have migrated to the islands before the mouse occupied the niche that they had opened. The question is different for a domestic animal, such as the pig, that humans deliberately take with them, as in the case of human expansion in the Pacific (Larson et al., 2007).

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The development of the individual character of the Canarian civilization can be explained all the more readily in that contacts with the rest of the world must have remained limited because of the sea barrier that separates the archipelago from the African continent. This gap is certainly modest in width, at its narrowest only about 100 kilometres, but is nevertheless significant because of the strength of the Canary current, swift and cold. The emergence of individual characteristics in the mouse population, both fossil and present-day, in no way contradicts this interpretation applied to humans. An initial population event, whether single or multiple, allowed mice to become established in a new environment, which was followed by an adaptation attested by the observed morphological changes mentioned above, and later batches of arriving mice have had only a slight influence on the previously established Canaries populations. Since the mouse's access to the islands was related to that of humans, the only consideration is the circumstances by which the latter made the crossing. Whether this was by a boat with a deck or on a raft, the actual conditions do not themselves add much to the success of voyages between the islands themselves or between the archipelago and the continent. Nevertheless, variations today between the years (Onrubia-Pintado, 1996) show that the speed of the current (which can reach up to 2 nautical miles per hour) accelerates at times of heavy trade winds, but slows at times of heavy African monsoon conditions, which draw warm tropical waters into more northerly latitudes. Some crossings would therefore have been less risky than others. But it must also be kept in mind that it is not possible to extrapolate from present-day conditions to cover the last ten thousand years or so: the region has known considerable climatic variation, with alternating wet and dry periods (Le Quellec 2004; Petit-Maire 2004; Soleilhavoup, 2005). During wet spells, the strength of the current would likely be diminished, and so the crossing become less of a risk. Such less unfavourable circumstances prevailed around the middle of the Holocene but disappeared at the end of the Middle Holocene, which was marked by a sudden and brutal drying-out of the whole zone. The study of the drill core sample ODP 658C, from off the coast of Cape Blanco (Mauretania), reveals a sudden and sharp increase in the index of wind-borne deposits coming from the Sahara around 4000 BCE (deMenocal et al., 2000), which is the indicator of the end of the 'green Sahara'. This climatic shift was a general one and has been identified for example under Mediterranean conditions in the Moroccan Middle Atlas (Cheddadi et al., 1998), but also in numerous other parts of the globe. This means that after 4000 BCE reaching the Canaries was much more difficult. It is nevertheless not possible to discard the possibility of human traverses during climatic fluctuations that were a little more marked than normal (J. Onrubia-Pintado, written communication). Figure 4 summarizes the main chronological data referred to.

In the present state of knowledge, the available periods relating to the human settlement of the Canary Islands indicate an arrival later than the onset of desertification in the Sahara. Considering the risk that sediments deposited in fissures or in caves at different times may have become mixed up, and given the necessity of a power of resolution in isotope dating to the century rather than to the millennium, no ^{14}C dating that has not been obtained from fossil material clearly established as being a mouse fossil can be considered as reliable (Michaux et al., 2007). Caution

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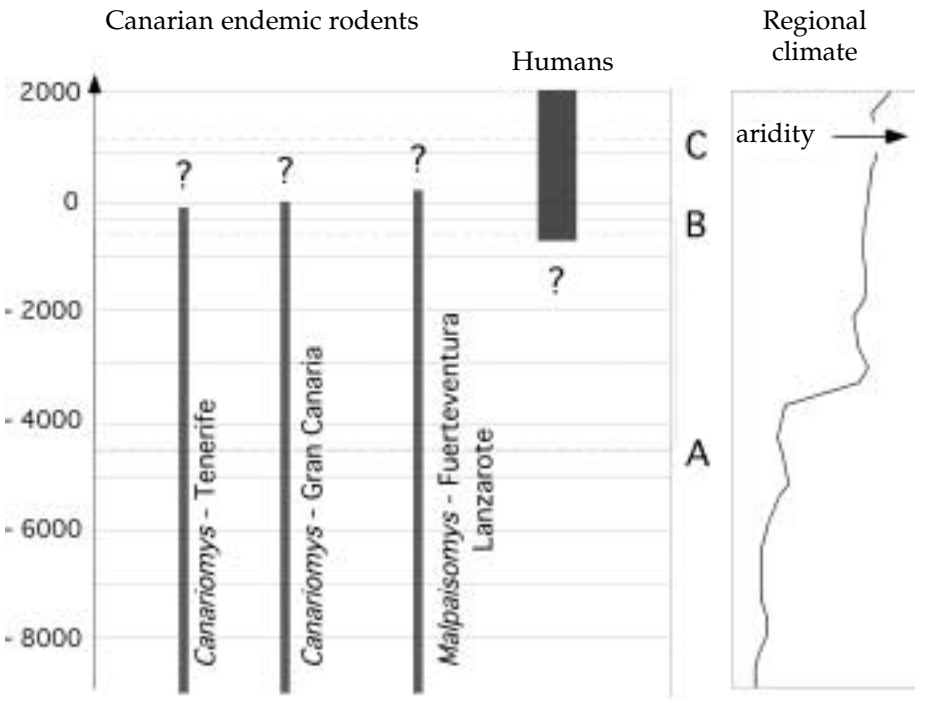

Figure 4. Chronological markers for the recent history of animal and human populations in the Canary Islands: extinctions of endemic rodents, arrival of humans, first presence of the mouse. A: oldest projected age for the presence of mice (Coello et al., 1999; Castillo-Ruiz et al., 2001); B: presence associated with that of the Guanches; C: lower limit after which, because of frequent contacts with Europe, the presence of mice is practically certain (14th–15th centuries). Regional shifts in the climate are given to the right (analysis of an oceanic core sample offshore from Cape Blanco, Mauretania, after deMenocal et al., 2000).

therefore leads one to retain for the moment a more limited tranche for the arrival of the mouse. This extends, at the earliest, from around the beginning of the Common Era, with this age supported by the dating of charcoal fragments in the Cueva de Villaverde, a Fuenteventura archaeological site (in Carrascosa and López Martínez, 1998) to, at the latest, the beginning of regular contacts between the archipelago and Europe, that is in the 15th century. Those responsible for the establishment of the mouse on the islands could well be the navigators of the ancient world. Only a significant exercise in high-resolution dating will be able to move the issue forward by indicating a precise date prior to which the absence of the mouse is very highly probable. Finally, it must be remembered that the earliest presence of human beings is not necessarily linked with the earliest presence of mice, as, in contrast to domestic animals, the mouse is a clandestine passenger.

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Conclusion

The extinctions affecting the endemic species of terrestrial vertebrates of the Canary Islands and the identification of the present-day and fossil mouse of the Canaries as *Mus musculus domesticus* leads us to envisage a cause-and-effect relationship between the extinctions and the arrival of humans, setting aside any hypothesis based on climate change. The particularities of the Canarian mice populations indicate, on the other hand, the significant role played by the islands' isolation, a condition equally responsible for the strong individuality of the Guanche civilization. In the absence of any direct dating of mouse remains, it is still not possible to retain a reliable date for the arrival of mice in the archipelago. For the moment, the date leaves an initial tranche of several thousand years for such an event, between the 5th millennium BCE and the 15th century of the modern era, a tranche whose lower limit remains nevertheless highly conjectural. The adoption of a specific programme of high-resolution ^{14}C dating directed at mouse remains, among other things, should rapidly enable these uncertainties to be resolved.

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Jacques Michaux
EPHE and University of Montpellier-II
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References

Auffray, J.-C., Tchernov, E., Nevo E. (1988) 'Origine du commensalisme de la souris domestique *(Mus musculus domesticus)* vis-à-vis de l'homme', *C. R. Ac. Sci. Paris*, 307 (III): 517–21.

Auffray, J.-C., Vanlerberghe, F., Britton-Davidian, J. (1990) 'The House Mouse Progression in Eurasia: A Palaeontological and Archaeozoological Approach', *Biological Journal of the Linnean Society*, 41: 13–25.

Bocherens, H., Michaux, J., Garcia Talavera F., van der Plicht, J. (2006) 'Extinction of Endemic Vertebrates on Islands: The Case of the Giant Rat *Canariomys bravoi (Mammalia, Rodentia)* on Tenerife (Canary Islands, Spain)', *C. R. Palevol.*, 5(7): 885–91.

Boye, P., Hutterer, R., López Martínez, N., Michaux, J. (1992) 'A Reconstruction of the Lava Mouse *(Malpaisomys insularis)*, an Extinct Rodent of the Canary Islands', *Zeitschrift für Säugetierkunde*, 57: 29–38.

Carrascosa, M. C., López Martínez, N. (1988) 'The House Mouse from a Prehistoric Site in Fuerteventura (Canary Islands)', *Bonner Zoologische Beiträge*, 39: 237–56.

Castillo-Ruiz, C., Martín González, E., Coello, J. J. (2001) 'Small Vertebrate Taphonomy of La Cueva del Llano, a Volcanic Cave on Fuerteventura (Canary Islands, Spain)', *Palaeogeography, Palaeoclimatology, Palaeoecology*, 166: 277–91.

Cheddadi, R., Lamb, H. F., Guiot, J., Van Der Kaars, S. (1998) 'Holocene Climatic Change in Morocco: a Quantitative Reconstruction From Pollen Data', *Clim. Dyn.*, 14: 883–90.

Coello, J. J., Castillo, C., Martín González, E. (1999) 'Stratigraphy, Chronology, and Paleoenvironmental Reconstruction of the Quaternary Sedimentary Infilling of a Volcanic Tube in Fuerteventura, Canary Islands', *Quat. Res.*, 52: 360–8.

Crusafont, M., Petter, F. (1964) 'Un muridé géant fossile des îles canaries *Canariomys bravoi gen. nov., sp. nov.* (Rongeurs, Muridés)', *Mammalia*, 28: 608–11.

Cucchi, T. (2005) *Le commensalisme de la souris et les premières sociétés néolithiques méditerranéennes*, Thèse. Paris: Muséum National d'Histoire Naturelle.

Cucchi, T., Vigne, J.-D., Auffray, J.-C., Croft, P., Peltenburg, E. (2002) 'Introduction involontaire de la souris domestique *(Mus musculus domesticus)* à Chypre dès le Néolithique précéramique ancien (fin IX^{e} et VIII^{e} millénaires av. J.-C.)', *C R Palevol*, 1: 235–41.

Cucchi, T., Auffray, J-C., Vigne, J-D. (2005) 'First Occurrence of the House Mouse (*Mus musculus domesticus* Schwarz & Schwarz, 1943) in the Western Mediterranean: a Zooarchaeological Revision of Subfossil Occurrences', *Biological Journal of the Linnean Society*, 84: 429–45.

Cucchi, T., Orth, A., Auffray, J.-C., Renaud, S., Fabre, L., Catalan, J., Hadjisterkotis, E., Bonhomme, F., Vigne, J.-D. (2006) 'A New Endemic Species of the Subgenus *Mus (Rodentia, Mammalia*) on the Island of Cyprus', *Zootaxa*, 1241: 1–36.

Darviche, D., Orth, A., Michaux, J. (2006) '*Mus spretus* et *Mus musculus* (Rodentia, Mammalia) en zone méditerranéenne: différenciation biométrique et morphologique et application à des fossiles marocains pléistocènes', *Mammalia*, 70: 90–7.

deMenocal, P. B, Ortiz, J., Guilderson, T., Adkins, J., Sarnthein, M., Baker, L., Yarusinski, M. (2000) 'Abrupt Onset and Termination of the African Humid Period: Rapid Climate Response to Gradual Insolation Forcing', *Quaternary Science Reviews*, 19: 347–61.

Guénet, J.-L., Bonhomme, F. (2003) 'Wild Mice: an Ever-Increasing Contribution to a Popular Mammalian Model', *Trends in Genetics*, 19: 24–31.

Hutterer, R., López Martínez, N., Michaux, J. (1988) 'A New Rodent from the Quaternary Deposits of the Canary Islands and its Relationships with Neogene and Recent Murids of Europe and Africa', *Palaeovertebrata*, 18: 241–62.

Larson, G., Cucchi, T., Fujita, M., Matisoo-Smith, E., Robins, J., Anderson, A., Rolett, B., Spriggs, M., Dolman, G., Kim, T. H., Thuy, N. T., Randi, E., Doherty, M., Due, R. A., Bollt, R., Djubiantono, T., Griffin, B., Intoh, M., Keane, E., Kirch, P., Li, K. T., Morwood, M., Pedrina, L. M., Piper, P. J., Rabett, R. J., Shooter, P., Van Den Bergh, G., West, E., Wickler, S., Yuan, J., Cooper, A., Dobney, K. (2007) 'Phylogeny and Ancient DNA of *Sus* Provides New Insights into Neolithic Expansion in Island Southeast Asia and Oceania', *Proceedings of the National Academy of Sciences USA*, 104: 12–16.

Le Quellec, J.-L. (2004) 'Une scène miniature incisée à Ti-n-taborak (Akâkûs) et ses implications pour la chronologie des gravures rupestres du Sahara', *Sahara*, 15: 59–74.

López Martínez, N., López Jurado, L. F. (1987) 'Un nuevo múrido gigante del Cuartenario de Gran Canaria *Canariomys tamarani* nov. sp. (Rodentia, Mammalia)', *Doñana. Acta Vertebrata*, 2: 1–66.

Mederos Martín, A., Escribano Cobo, G. (2002) *Los aborígenes y la prehistoria de Canarias*. Tenerife: Centro de la Cultura Popular Canaria.

Michaux, J., Cucchi, T., Renaud, S., Garcia-Talavera, F., Hutterer, R. (2007) 'House Mice in the Canary Islands: Morphometrics of Teeth Reveals a Complex History of Colonization and Evolution', *Journal of Biogeography*, 34: 1412–25.

Morales Muñiz, A., Cereijo Pecharroman, M. A., Hernández Carrasquilla, F., von Lettow-Vorbeck, C. L. (1995) 'Of Mice and Sparrows: Commensal Faunas from the Iberian Iron Age in the Duero valley (Central Spain)', *International Journal of Osteoarchaeology*, 5: 127–38.

Onrubia-Pintado, J. (1996) 'Archéo-écologie des occupations humaines holocènes du bassin côtier de Tarfaya', in J. Riser (ed.), *Le Bassin de Tarfaya (Maroc atlantique, 28° nord). Paléoenvironnements,*

Paléoanthropologie, Préhistoire, pp. 237–56. Paris: L'Harmattan.
Petit-Maire, N. (2004) 'Climatic Crises and Man in the Mediterranean Basin: The Last 20 000 Years', in *Human Records of Recent Geological Evolution in the Mediterranean Basin – Historical and Archaeological evidence*, CIESM Workshop Monographs (Monaco), 24, pp. 17–24.
Pomey, P. (1997) *La Navigation dans l'Antiquité*. Aix-en-Provence: Edisud.
Soleilhavoup, F. (2005) 'Images "Têtes rondes" dans l'art rupestre saharien: la piste animiste', *Sahara*, 16: 91–106.
Stoetzel, E., Nespoulet, R., Michel, P. (2006) 'Les environnements holocènes du littoral atlantique du Maroc. Exemple des petits et grands vertébrés en contexte archéologique provenant de la grotte d'El Harhoura 2, région de Temara', *Le Quaternaire, Limites et Spécificités*, Colloque International Q5 (Paris), Résumés.
Vigne, J.-D., Cucchi, T. (2005) 'Premières navigations au Proche-Orient: les informations indirectes de Chypre', in J. Desse, N. Desse-Berset (eds), *Past Exploitations of Aquatic Ecosystems in South-West Asia*, *Paléorient*, 31(1): 195–204.
Vogel, P., Cosson, J. F., López Jurado, L. F. (2003) 'Taxonomic Status and Origin of the Shrews *(Soricidae)* from the Canary Islands Inferred from a mtDNA Comparison with the European *Crocidura* Species', *Molecular Phylogenetics and Evolution*, 27: 271–82.