

Radiocarbon dating of introduced mammals: a genet (*Genetta genetta*) from a Prehistoric site dated in Islamic times

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There is a general agreement that the common genet (*Genetta genetta* (Linnaeus, 1758); Carnivora, Viverridae), which at present occupies the Iberian Peninsula, the south of France and some Balearic Islands in Europe (Mitchell-Jones *et al.* 1999), has been intentionally introduced by humans (Dobson 1998, Kurten 1968). Many authors argue that the species was used by different people as a tamed predator to control rodents and insects before the expansion of the domestic cat (e.g. Kingdon 1977, Livet & Roeder 1987, Larivière & Calzada 2001, Faure & Kitchener 2009), but evidences supporting this hypothesis are scarce. It is not clear yet what people brought the genets to Europe and when did this introduction occur (e.g. Gaubert *et al.* 2011). One of the reasons for this ignorance is the relative scarcity of genet remains in archaeological sites. Besides, some genet remains could be inaccurately dated, being more recent than the archaeological levels at which they were found. This is because genets, like some other medium-size carnivores, use burrows and other cavities, and their remains can thus move through the sedimentary sequence. For this reason, the inference of the date of arrival of introduced mammals into Europe should be preferentially based in the AMS radio-carbon dating (see below for a description) of the scarce remains, instead of in the dating of accompanying archaeological materials.

Until now, it has been usually accepted that the oldest genet remains discovered in Europe were those identified by Morales (1994) in an Almohad site in Mértola, southern Portugal, from the early 13th century AD. Morales found the hemipelvis of a genet in a sealed cesspit, together with remains of black rats (*Rattus rattus*) and a bone of hare (*Lepus granatensis*) that would have been bitten by the

genet after being discarded by people, suggesting a commensal behavior. This observation lead to the suggestion that the genet had been introduced in southern Spain by the Almohads (Gaubert *et al.* 2009, Masseti 2009), an Arab dynasty that ruled the southern half of the Iberian Peninsula since the mid-12th to the early-13th centuries AD, approximately.

However, the archaeological literature contains a small number of records of putatively older genets that have remained unnoticed for mammalogists (e.g. Estévez 1980, Arribas 2004). The correct dating of these genet remains would be relevant to elucidate the process of colonization of Europe by the species. Here we present the results of the radiocarbon dating of the hemimandible of a genet found in 1977 at the Covacha de la Presa (Loja, Granada). Because of its archaeological context (see below), the specimen was reported as “the oldest (of the species) known in the Iberian Peninsula” (Carrasco *et al.* 1977; p. 149).

The archaeological site

The details of the site and the excavation described here have been obtained from Carrasco *et al.* (1977). The Covacha de la Presa is placed at the southeast and very close to Loja village, Granada (approximately 37°03'05"N, 4°01'19"W). It is a small cave of funnel shape, with a mouth of 1.25 m diameter, 4.7 m of maximum length, 2.0 m wide and 4.5 m high. It belongs to the Sierra Gorda massif and was formed on limestone of Lower Jurassic strongly karstified by underground water. The hazardous finding of the cave in 1975 revealed the site had been repeatedly visited by grave robbers,

probably since the Roman period, but also the existence of a variety of goods related to a human burial of the Copper Age. A formal archaeological excavation was not made, but a systematic study of the grave bones and goods was carried out in 1977 by members of the Department of Prehistory of the University of Granada.

The Covacha was used exclusively for collective burials, discarding the possibility it was a habitat place. Most human bones had been removed and crowded when discovered, but they corresponded at least to 68 individuals. Physically, most of them were described as delicate, according the common type of European Mediterranean skeletons at that time, but some ones were considered robust, rather similar to the aboriginals of Canarias and North Africa. Determining an accurate stratigraphy can be difficult in collective burials, especially if they have been modified by treasure hunters, but a cultural sequence can be recognized from the typology of the goods: 1) The oldest cultural period, without metals and with silex knives and ceramic pieces of gross paste, would correspond to the Final Neolithic/Early Copper Age, about the 3rd millennium BC; 2) The medium cultural period included typical burials of the Campaniforme (Bell Beaker) culture of the Copper Age, with plates, copper punches, tongue daggers, etc., corresponding to the 3rd-2nd millennium BC; 3) The last cultural period included the more recent burials, with cups of clear Argar type, silver rings, gold beads, etc., corresponding to the 2nd millennium BC, at the beginning of the Bronze Age. Besides, among the scrambled surface materials some pieces of glass of Roman origin were also found.

The faunal remains recovered (determined by Dr. A. Ruíz Bustos, University of Granada) revealed the presence of wild as well as domestic animals. Mammal remains included those of *Oryctolagus cuniculus*, *Sus scrofa* (wild and domestic varieties), *Cervus elaphus*, *Bos taurus* (domestic), unidentified Ovicapridae, *Canis familiaris*, *Arvicola sapidus*, an unidentified Mustelidae and a right hemimandible of *Genetta genetta* (erroneously, Carrasco et al. 1977 reported that the piece included M₁-M₃ teeth, when they were in fact P₃-M₁; Fig. 1). There are also birds as *Alectoris rufa*, reptiles as *Mauremys leprosa* and *Natrix* sp., and shells of marine bivalves and terrestrial snails. Judging by the cultural archaeological context, these remains were estimated to be between 3500-4500 years old.

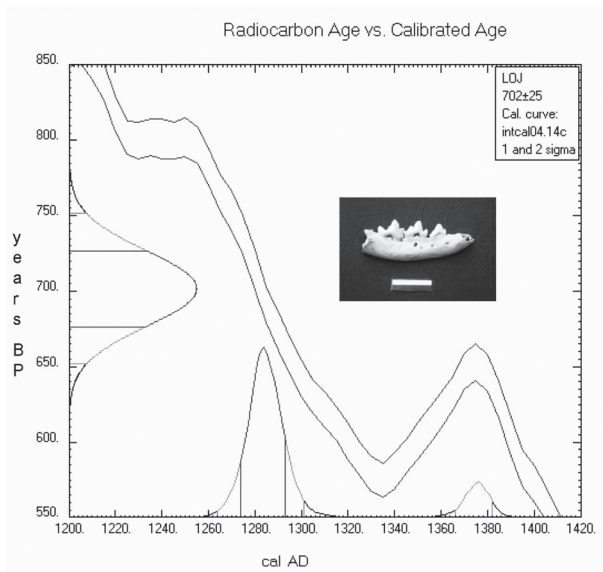


Figure 1. AMS radiocarbon *vs.* calibrated dating of the genet (*Genetta genetta*) of Covacha de la Presa (Loja, Granada, Spain). The ordinate axis shows radiocarbon concentration expressed in years before present and the abscissa axis shows calendar years derived from tree ring data. Quasi-parallel transversal curves show the radiocarbon measurements on the tree rings (mean \pm SD). The curve on the ordinate axis indicates the radiocarbon concentration in the sample. The double-curve on the abscissa axis shows calibrated probable ages for the sample (the higher the curve, the more likely that age; see Talma and Vogel 1993). In the middle, we have included a picture of the genet hemimandible recovered at the archaeological site.

The AMS radiocarbon dating

The radiocarbon dating method is based on the rate of decay of the unstable carbon isotope ^{14}C , which is formed in the upper atmosphere and enters into plants and animals through photosynthesis and the food web. When a living being dies and its metabolism ceases, there is no replenishment of radioactive carbon in its tissues, only decay. Libby et al. (1949) were the first to measure the rate of this decay, finding a half-life for ^{14}C of 5568 ± 30 years (the Libby half-life). At present ^{14}C counting was usually made through the Accelerator Mass Spectrometry (AMS) method. Radiocarbon measurements are reported as years before present (BP) and are based on the proportion of ^{14}C found in the analyzed sample. They are calculated assuming that the atmospheric ^{14}C concentration has been always the same as it was in 1950 (assuming that “present” refers to 1950).

However, the proportion of radiocarbon in the atmosphere has varied by a few percent over time and the true half life of radiocarbon is 5730 years, not the original value measured by Libby et al. (<http://www.c14dating.com/> consulted at November 29, 2014). Thus, a conventional radiocarbon determination must be calibrated considering how the atmospheric concentration has changed with time. Proportion of ^{14}C in tree rings of known calendar age is directly compared with that of the sample, in order to calibrate radiocarbon record (see Talma & Vogel 1993). The results of calibration are given as a calendar age probabilistic range, usually covering 95%, and are expressed as years cal AD (Anno Domini).

The mandible of the genet was sent for AMS radiocarbon dating to the Centro Nacional de Aceleradores from the University of Sevilla, Spain (<http://www.centro.us.es/cna>). After cleaning the sample with an acid-base-acid treatment, the collagen was extracted and purified. The estimated age from conventional radiocarbon was 700 ± 25 BP. When calibrated, 88.4% of probabilities place the genet between 1265 AD and 1302 AD, while 11.6% of probabilities place it later, between 1367 AD and 1383 AD (Fig. 1). The report was signed by F.J. Santos Arévalo and I. Gómez Martínez. Unfortunately, the sample was totally consumed during the dating process and no additional studies (e.g. genetics) are possible.

Conclusion

The genet of Covacha de la Presa was dated in the last portion of the 13rd century AD or later. By that time the rule of the Almohads in southern Iberia had come to an end, being substituted by the Benimerines or Merinids. However, this historical context is not relevant for the question of the origin of European genets, as some older individuals had been found previously (e.g. Morales 1994). Elsewhere, the trade of genet furs originating from Iberian Peninsula seemed to be common in Europe already at the 13th century (Delort 1978, p. 175). The more interesting conclusion of this work is to emphasize the importance of radiocarbon dating of ancient animal remains instead of directly assigning them the age of other remains from the sites where they appeared. Previous works have already proven that remains of presumably introduced mammals found

in old deposits were in fact much more recent than their archaeological context. For instance, an Algerian hedgehog (*Atelerix algirus*) from a Bronze Age grave of Minorca (Balearic Islands, Spain) was assigned to the 13rd century AD after AMS radiocarbon dating (Morales & Rofes 2008). Also, Egyptian mongooses (*Herpestes ichneumon*) recovered from Prehistoric sites of Nerja (Málaga, Spain) and Muge (Portugal) were radiocarbon dated approximately at the 12rd and 9rd centuries AD, respectively (Riquelme-Cantal *et al.* 2008; Detry *et al.* 2011). In this same line, Estévez (1980) indicated the genet found in a talayotic site of Son Fornés, Majorca (Balearic Islands, Spain) was more recent than the site, writing that “the presence of the Balearic genet (...) is clearly intrusive”, p. 379. Consequently, caution should be applied when interpreting other undated, putatively ancient remains of genets, such as those reported by Arribas (2004) in Montségur (France) and Girona (Spain).

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