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Detecting the T1 cattle haplogroup in the Iberian Peninsula from Neolithic to medieval times: new clues to continuous cattle migration through time

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ABSTRACT

The spread of domestic animals through time is one of the topics studied by archaeologists to assess human trade and migration. Here we present mitochondrial analysis of 42 archaeological cattle (*Bos taurus*) bone samples, from 16 different sites in the Iberian Peninsula and covering a broad timeframe (from the early Neolithic to the Middle Ages), to provide evidence about the origin and dispersion of the T1 cattle haplogroup in relation to human contacts and movements. The presence of the T1 haplotype in one sample from an early Neolithic site close to the Mediterranean coast of Iberia, and its continuing presence in the Peninsula during Roman and Medieval times, clearly demonstrates that T1 was not solely a Muslim or later introduction. Rather, our molecular data show evidence for a pioneer coastal colonisation of the Iberian Peninsula from the Mediterranean basin, followed by possible further colonisation, leading to a continuity of diversity through time.

1. Introduction

The origin and diversification of domestic taurine cattle (*Bos taurus*) has been extensively investigated using mitochondrial (mt) DNA analyses of both modern and ancient samples. The majority of modern taurine mtDNA sequences in Europe fall into one of four phylogenetically distinct, yet closely related, star-like haplogroups, termed T, T1, T2 and T3. High diversity has been documented in Anatolia and the Middle East for both modern (Troy et al., 2001) and Neolithic and Bronze Age (Bollongino et al., 2006, 2012) specimens. The diversity in Europe and in Africa are both subsets of that seen in the Near East, with the most frequently observed haplogroups being T3 and T1 respectively. These results have been interpreted as a scenario of a single Neolithic origin of all T haplogroups in the Near and Middle East and a subsequent spread towards Europe and Africa (Troy et al., 2001; Bollongino et al., 2006; Lenstra et al., 2014). However, it appears that the process of cattle domestication and diffusion was more complex than

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originally thought, with a fifth haplogroup, T5, and two novel haplotypes (Q and R), recently reported from a small number of extant Italian cattle (Achilli et al., 2008, 2009). In addition, evidence of T3 being predominant in Italian aurochs (Beja-Pereira et al., 2006; Mona et al., 2010; Lari et al., 2011) is suggestive that at least some Mediterranean T3 maternal lineages may have a European, rather than a Southwest Asian, origin.

Similarly to T3 in Europe, T1 is fixed in the majority of extant African cattle (Lenstra et al., 2014), but it also found at low numbers in some contemporary Iberian, Italian and Greek breeds (Bradley et al., 1996; Cymbron et al., 1999; Beja-Pereira et al., 2006; Dadi et al., 2009; Bonfiglio et al., 2012). Research supports a spread of domestic T1 cattle from the Near East towards southern Europe and the Mediterranean basin during the Neolithic (Troy et al., 2001; Bollongino et al., 2006; Achilli et al., 2008; Lenstra et al., 2014), with the possibility that hybridisation occurred between migrating domestic populations from the Near East and resident wild African populations (Achilli et al., 2008; Decker et al., 2014).

Specifically for the Iberian Peninsula, different explanations for the presence of T1 mitotypes in Iberian cattle breeds have been hypothesised. There is evidence for a wholly or partially North African origin for domestic cattle in Iberia (Cymbron et al., 1999; Miretti et al., 2002; Anderung et al., 2005; Beja-Pereira et al., 2006; Ginja et al., 2010), and a number of time periods for these origins and subsequent migrations have been identified. Possible introgressions of North African cattle into Iberia have been attested to have occurred: (1) during the Muslim invasion and occupation in the 8th century AD (Cymbron et al., 1999, 2005; Beja-Pereira et al., 2006); (2) as a consequence of the colonial activities in the 18th century AD (Cymbron et al., 1999); or (3) due to recent gene flow from Africa derived in the 1960s and 1970s (Beja-Pereira et al., 2002, 2003). However, the T1 haplogroup has been observed in a single Bronze Age animal from the north of Iberia (Anderung et al., 2005), highlighting that T1 was not only a recent introduction into the area. Taking these considerations into account, the aim of the research reported in this paper was to understand the phylogeny of

Table 1
Data of archaeological Spanish cattle used in this study. Table of archaeological cattle samples studied, with associated information.

Lab code	Sample code	Site	Area	Period	Date	Fragment length	Haplogroup	Source
NEOL01	Spain 04	Cova de l'Or	Alicanti	Neolithic	5400 cal. BC	240 bp	T3	this study
NEOL02	Spain 05	Cueva del Mirador	Atapuerca	Neolithic	5400 cal. BC	240 bp	T3	this study
NEOL03	IBE6	La Draga	Girona	Neolithic	5213–5044 cal. BC	240 bp	T1	this study
BRON01	IBE4	Gatas	Almeria	Bronze Age	1900–1700 cal. BC	240 bp	T	this study
BRON02	MAD17	Portalón	Burgos	Bronze Age	1800 cal. BC	240 bp	T3	AY847199
BRON03	MAD2	Portalón	Burgos	Bronze Age	1780 cal. BC	240 bp	T3	AY847188
BRON04	MAD3	Portalón	Burgos	Bronze Age	1780 cal. BC	240 bp	T3	AY847189
BRON05	MAD5	Portalón	Burgos	Bronze Age	1780 cal. BC	240 bp	T3	AY847190
BRON06	MAD8	Portalón	Burgos	Bronze Age	1780 cal. BC	240 bp	T3	AY847192
BRON07	MAD9	Portalón	Burgos	Bronze Age	1780 cal. BC	117 bp	T/T3	AY847193
BRON08	MAD10	Portalón	Burgos	Bronze Age	1780 cal. BC	240 bp	T	AY847194
BRON09	MAD11	Portalón	Burgos	Bronze Age	1780 cal. BC	240 bp	T3	AY847195
BRON10	MAD14	Portalón	Burgos	Bronze Age	1780 cal. BC	240 bp	T3	AY847196
BRON11	MAD18	Portalón	Burgos	Bronze Age	1780 cal. BC	240 bp	T3	AY847200
BRON12	MAD51	Valparaiso de Abajo	Cuenca	Bronze Age	1780 cal. BC	240 bp	T3	AY847211
BRON13	MAD16	Portalón	Burgos	Bronze Age	1740 cal. BC	240 bp	T1	AY847198
BRON14	MAD6	Portalón	Burgos	Bronze Age	1635 cal. BC	240 bp	T3	AY847191
IRON01	MC36	St. Julià Ramis	Girona	Iron Age	5th–3rd c. BC	119 bp	T/T3	JX876556
ROMN01	MC37	Olivet d'en Pujol	Girona	Roman	1st c. BC	119 bp	T/T3	JX876557
ROMN02	MC38	Olivet d'en Pujol	Girona	Roman	1st c. BC	119 bp	T/T3	JX876558
ROMN03	MC1	Vilauba	Girona	Roman	1st c. AD	119 bp	T/T3	JX876553
ROMN04	MC9	Baetulo	Barcelona	Roman	2nd c. AD	119 bp	T/T3	JX876554
ROMN05	MC18	Vila Ametllers	Girona	Roman	1st–3rd c. AD	119 bp	T/T3	JX876555
ROMN06	IBE5	Son Fornés	Mallorca	Roman	2nd BC-1st c. AD	240 bp	T1	this study
ROMN07	EM20	Empúries	Girona	Roman	3rd c. AD	mosaic	?	this study
ROMN08	EM21	Empúries	Girona	Roman	1st c. AD	67 bp	T/T3	this study
ROMN09	EM22	Empúries	Girona	Roman	2nd c. AD	240 bp	T3	this study
ROMN10	EM26	Empúries	Girona	Roman	3rd c. AD	mosaic	?	this study
ROMN11	EM27	Empúries	Girona	Roman	3rd c. AD	316 bp	T3	this study
ROMN12	EM28	Empúries	Girona	Roman	1st c. AD	240 bp	T3	this study
ROMN13	EM50	Empúries	Girona	Roman	1st c. AD	316 bp	T3	this study
ROMN14	EM51	Empúries	Girona	Roman	2nd c. BC	316 bp	T3	this study
ROMN15	EM52	Empúries	Girona	Roman	1st c. AD	175 bp	T/T3	this study
ROMN16	EM55	Empúries	Girona	Roman	1st–3rd c. AD	mosaic	?	this study
ROMN17	EM57	Empúries	Girona	Roman	3rd c. AD	316 bp	T3	this study
ROMN18	EM80	Empúries	Girona	Roman	1st c. BC	316 bp	T1	this study
ROMN19	EM81	Empúries	Girona	Roman	2nd c. AD	203 bp	T1	this study
ROMN20	EM82	Empúries	Girona	Roman	3rd c. AD	175 bp	T/T3	this study
MIDD01	IBE2	Montsoriu	Barcelona	Middle Age	900–1200 AD	240 bp	T1	this study
MIDD02	MAD47	Cueva de Joaquin	Teruel	Middle Age	1120 AD	117 bp + 100 bp	T3	AY847208
MIDD03	MAD19	San Pablo	Burgos	Middle Age	1300–1500 AD	240 bp	T3	AY847201
MIDD04	MAD20	San Pablo	Burgos	Middle Age	1300–1500 AD	240 bp	T3	AY847202
MIDD05	MAD22	San Pablo	Burgos	Middle Age	1300–1500 AD	117 bp + 100 bp	T3	AY847203
MIDD06	MAD23	San Pablo	Burgos	Middle Age	1300–1500 AD	240 bp	T3	AY847204
MIDD07	MAD25	San Pablo	Burgos	Middle Age	1300–1500 AD	240 bp	T3	AY847205