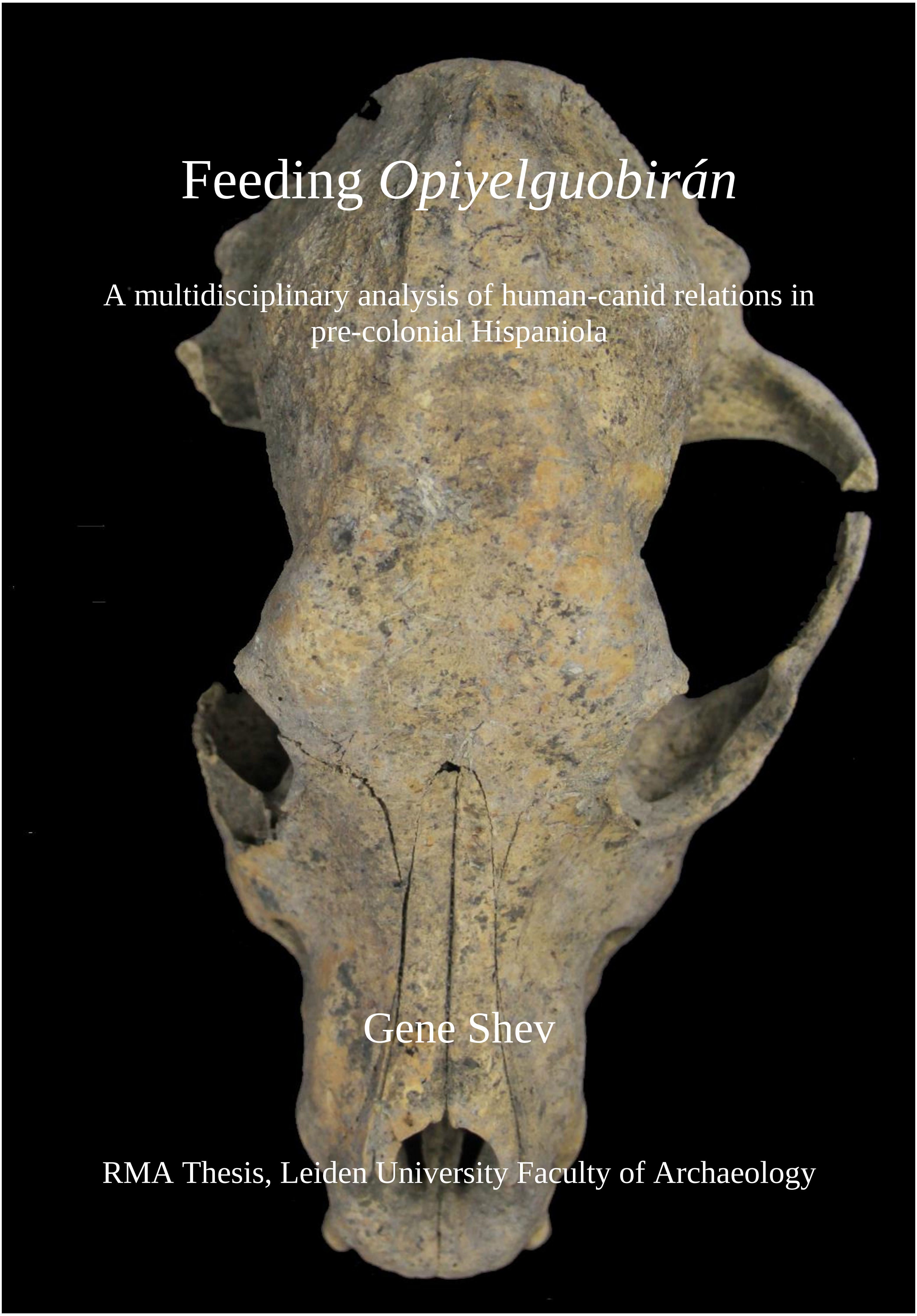

Feeding *Opiyelguobirán*

A multidisciplinary analysis of human-canid relations in pre-colonial Hispaniola

Gene Shev

RMA Thesis, Leiden University Faculty of Archaeology

Front cover image: *Canis lupus familiaris* crania recovered from the precolonial archaeological site of El Flaco, Dominican Republic (FND 2270). Copyright NEXUS 1492. Photograph taken by the author.

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Gene Shev (s1790854)

RMA: Religion and Society in Native American Cultures

Supervisors: Prof dr C.L. Hofman and Dr J.E. Laffoon

Leiden University, Faculty of Archaeology

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Chapter One: Introduction

As the first animal to be domesticated, the dog (*Canis lupus familiaris*) shares a long-standing relationship of entanglement with humans. This is exemplified in the introduction of dogs into every inhabited continent, likely migrating alongside humans as valued hunting partners, companions, guardians, living totems, beasts of burden, and occasionally, as prey (Russell 2012). The nature of human-canid relationships is nuanced and varied, and compared to any other animal dogs feature most prolifically in ritual burials across the globe (see Bökönyi 1975; 1983; Bonnet *et al*., 1989; Clutton-Brock 1995; Grouard *et al.* 2013; Lechevallier *et al*., 1982; Tchernov and Valla 1997; Valadez Azúa *et al.* 2013), suggesting their potency as a symbol, and their revered status as an animal considered worthy of personhood and as important members of the family, community and social pact.

Within the insular Caribbean, *C. familiaris* was likely introduced by humans during the Early Ceramic Age (c. 400 BC - AD 500), subsequently disseminating throughout the entire Greater and Lesser Antilles (Newsom and Wing 2004). Elucidating the treatment and role of dogs within pre-colonial societies is pivotal for understanding the functioning of indigenous human-animal relationships, and for establishing cultural taxonomies affecting the preferential treatment of some animals over others. Determining the treatment and role of dogs in the pre-colonial societies of the insular Caribbean is of particular importance, being one of only two domesticated animals that were introduced from the mainland Americas, the other being the guinea pig (Kimura *et al.* 2016; Newsom and Wing 2004). In the Caribbean islands, no other animal likely shared as highly entangled lifeways with Amerindians in the region (LeFebvre and deFrance 2012; Wing 1991; 2001). A multidisciplinary approach to assessing the archaeological remains of dogs in the insular Caribbean has potential to allow a more holistic interpretation of the role of this animal within the pre-colonial Amerindian societies of the region.

1.1 Problem Statement

Unlike all other animals found in pre-colonial archaeological sites in the insular Caribbean, the majority of dog remains are found in burial contexts, either individually or collectively interred with humans (Grouard 2000; 2001; *et al.* 2013; Hofman *et al.* 1999; Hoogland and Hofman 2013; Laffoon *et al.* 2013; Newsom and Wing 2004; Plomp 2013a; 2013b). Dichotomously, the archaeological evidence and early ethnohistoric accounts indicate that Amerindians in the Antilles also considered dogs as a viable source of food (Grouard 2001; *et al.* 2013; Las Casas 1857). This evidence of human consumption stands in contrast to the commonality of ritual burial practices, symbolic depictions, and recorded religious beliefs in early European accounts that hint at the importance of this animal within the cosmological rationale of Amerindians (Roe 1995; Schwartz 1997). This raises an important question; why one dog was worthy of the grave, whilst the other the plate?

Although there has been the extensive isotope palaeodietary reconstruction conducted on human remains in the pre-colonial Caribbean, limited studies have been conducted on animal diets (see LeFebvre *et al.* 2017; Pestle 2010). In the case of dogs, only a few studies provide multi-isotopic data determining dietary makeup and provenance. These studies include multi-isotopic analyses of both dogs and humans from the sites of Anse à la Gourde and Morel in Guadeloupe, El Cabo and El Flaco in the Dominican Republic, and one dog bone from Punta Candelero in Puerto Rico (Booden *et al.* 2008; Laffoon *et al.* 2012; 2015; 2017; Pestle 2010, 429). These analyses have indicated a degree of dietary entanglement shared between humans and dogs (Laffoon *et al.* 2017). However, in trying to determine if this trend of dietary entanglement is a region-wide phenomenon, further multi-isotopic investigation of *Canis lupus familiaris* is required. Additionally, an investigation of whether there are differences in the diets of some dogs compared to dogs would be beneficial for understanding whether certain dogs were being treated differently, not only in death but during their lives.

Our knowledge of the cultural institutions of indigenous Antilleans is unfortunately limited, being largely educated by scant archaeological evidence and early European ethnohistorical sources. This lacuna of knowledge also prevents a thorough understanding of Amerindian environmental perspectives and the functioning of human-animal relations. For this reason, a multidisciplinary approach that generates empirical data detailing the treatment of dogs by humans, and applies ethnographic analogy and ontological theory to assess the cultural rationales behind this treatment, can provide a more holistic analysis of the functioning of human-animal relations in the precolonial insular Caribbean.

1.2 Research questions

To address the lacunae of knowledge regarding the determining of preferential treatment of some dogs over others, and to examine the possible cultural rationales governing the flexible, dichotomous treatment of dogs, the following main research question and sub questions are posed:

- How can the data garnered from the synthesis of techniques from the biological sciences be interpreted according to Amerindian perspectival theory, ethnographic analogy and ethnohistoric sources to understand the cultural rationales governing the dualistic treatment of dogs in the pre-colonial insular Caribbean?

- What can be determined about the morphology of dogs and the treatment conferred on dogs by the indigenous inhabitants of Hispaniola according to data gained from archaeozoological investigation?
- What can multi-isotopic analyses of dog remains illuminate about human-influenced feeding regimes, preferential treatment, animal mobility and shared dietary relationships with humans?

1.3 Objectives

This study employs a multidisciplinary approach to establish a biography of the treatment of dogs by humans at the two pre-colonial sites of El Flaco and El Carril in the modern-day Dominican Republic. The objective is to incorporate archaeozoological and stable isotope ratio analyses in the study of dog remains from these two case study sites. The employment of archaeozoological methodologies aims to establish the morphologies of dogs from El Flaco and El Carril, and indicate the nature of their treatment by humans. Additionally, multi-isotopic analysis of dog remains may provide more evidence pertaining to the lifeways of dogs by the establishment of their palaeodiets and mobility patterns. To interpret this data, this study will incorporate analogous information pertaining to the role of dogs from early European ethnohistoric records from the region, and modern ethnographic analogies from lowland South America. To shed light on the indigenous perspectives that may have affected the dualistic treatment of dogs, ontological theories describing Amerindian worldview (Viveiros de Castro 1998) will be employed. The generation of data from the aforementioned scientific techniques aims to provide an understanding of *how* canids were treated by the indigenous inhabitants of Hispaniola, whilst the ontological approach and ethnographic analogies will aim at highlighting the reasons *why* differential treatment by humans was occurring with this animal.

1.4 Theoretical framework

To understand why some dogs were being treated with the same rites of burial that would normally be attributed to a person, and why some were possibly being consumed, it was important to try and understand the ontological reasoning governing the functioning of human-animal relationships in the region. To develop a conception of the culturally-dictated cosmological rationales affecting the treatment of dogs in the insular Caribbean, ethnographic analogies from lowland South America will be investigated. The reasoning behind the choice of utilising information from ethnographic studies from lowland South America lies in the observable correlates in the archaeology of the insular Caribbean with that region, as well as archaeological evidence suggesting that the Orinoco basin was from where some key elements of pre-colonial cultures in the insular Caribbean originated

(Heckenberger 2002; Rouse 1992; Siegel 1991). However, the possibility remains many indigenous Antillean cultural institutions have multi-regional origins (Rodríguez Ramos 2013). Therefore, the employment of ethnographic information from lowland South America only provides analogies of the nuanced role of dogs within Amerindian societies and does not strictly imply a sense of cultural uniformitarianism between two temporally and geographically distinct cultural groups.

To attribute personhood to an animal, particularly that of a dog (see Losey *et al.* 2011), and to dichotomously view it as a food sources, implies a flexible conceptual attitude to animals within Amerindian worldviews. Viveiros de Castro's (1998) theory of 'Amerindian perspectivism' and Philippe Descola's (1998; 2013) notion of animism provide theoretical frameworks to attempt to understand how the dog fits into the cosmological praxis of the indigenous peoples in the Caribbean. Amerindian perspectivism will be employed as a theoretical tool for assessing the ontologies of the pre-colonial inhabitants of Hispaniola. The employment of perspectival theory in this study will also assess the efficacy of this approach in interpreting pre-colonial Antillean worldviews, particularly given that this ontological theory was established from studies of indigenous groups from Amazonia and does not wholly apply to all Amerindian cosmologies. Even with this caveat, Amerindian perspectivism is a theory concerned with human perspectives of animals in Amerindian societies, and therefore has potential for assessing the cosmological rationales dictating the role of dogs within pre-colonial societies from the insular Caribbean.

1.5 Methods and Approach

A suite of analytical techniques will be utilised in the examination of *C. familiaris* skeletal material from two Late Ceramic Age sites from the Dominican Republic; El Flaco and El Carril. Archaeozoological analysis and stable isotope ratio analysis will coalesce within a multidisciplinary methodological approach to develop a living and post-mortem biography of the treatment of dogs by humans, and therefore elucidate general animal husbandry practices and potentially establish instances of preferential treatment of some dogs over others.

The first portion of this study will involve the archaeozoological analysis of *C. familiaris* skeletal remains to investigate the relative proportions of certain elements represented in these assemblages, interpret the depositional context, determine evidence of butchery, reconstruct the morphological characteristics of these animals, and estimate mortality ages. Qualitative analysis of bone surface modification indicative of human action will be conducted, whilst morphometric data will be used to reconstruct the body size and mass of the applicable specimens. Age determinations will be made possible by an examination of epiphyseal fusion rates in skeletal elements (Sumner-Smith 1961) and known rates of tooth eruption (Geiger *et al.* 2016).

A selection of *C. familiaris* bones from El Flaco and El Carril will undergo collagen extraction to assess protein intake via the analysis of carbon ($\delta^{13}C_{co}$) and nitrogen ($\delta^{15}N$) values. Samples of *C. familiaris* teeth from El Flaco and El Carril will undergo enamel extraction to assess $\delta^{13}C_{en}$ values indicative of the whole diet of an organism, and strontium ($^{87}Sr/^{86}Sr$) ratios that can potentially determine the original geographic origin of an animal (Bentley 2006). The isotopic values of bone collagen and enamel samples are to be measured at the Stable Isotope Lab, Faculty of Earth Sciences, VU Amsterdam. As previously conducted isotopic studies of dogs in the insular Caribbean have largely focussed on dental enamel, an analysis of the isotopic values present in bone collagen will provide further indications of whole diet by illuminating the consumption of different sources of protein (DeNiro and Epstein 1980; Fernandez *et al.* 2012; Froehle *et al.* 2010).

Further comparative data pertaining to human and dog palaeodiets from the insular Caribbean is made available in previously published reports (see Hofman *et al. in prep*; Laffoon 2017; Pestle 2010; Stokes 1998). Additional comparative dog bone samples are to be analysed for collagen isotope values as part of this study. These comparative samples are supplied courtesy of Dr Sandrine Grouard from the Muséum National d'Histoire Naturelle (MNHM) in Paris and are from the Lesser Antillean sites of Morel and Cathédrale de Basse-Terre in Guadeloupe, and Hope Estate, St Martin. This extraneous published and unpublished data will allow an interregional and inter-temporal comparison of canine diets between El Flaco and El Carril and elsewhere in the Greater and Lesser Antilles, enabling a more detailed analysis of potential differences in diet according to whether dogs were recovered from burial or non-burial contexts.

1.7 Outline of the thesis

Chapter Two describes the current state of knowledge concerning the role of domestic dogs in the insular Caribbean. This chapter includes an overview of the archaeological and genetic evidence pertaining to the earliest instances of dog domestication in Eurasia and discusses the introduction of dogs into the Americas and the insular Caribbean. It provides a regional overview of instances of dog burials and examples of artistic depictions of dogs in cultural artefacts and petroglyphs. Additionally, an overview of ethnohistoric accounts detailing the treatment and appearance of dogs is given, including a description and analysis of the 'Taíno' dog-like deity *Opiyelguobirán* as recorded by Fray Ramon Pané (Pané 1999). The chapter concludes with an overview of various ethnographic analogies of the treatment of dogs in lowland South America, including an assessment of how dogs fit into the cosmological rationale of certain mainland groups of Cariban and Arawakan speaking peoples, as exemplified in their folklore.

Chapter Three consists of an overview of recent post-humanist theory promoting the acknowledgement of the agency of animals in determining human behaviour, and the possibility of establishing ‘multispecies ethnographies’ by doing so. The chapter provides definitions of Amerindian animist worldviews as noted by Philippe Descola (2013) and others, and gives an overview of the ethnological theory of Amerindian perspectivism formulated by Viveiros de Castro (1998). This chapter concludes by illustrating how these theoretical approaches can be used to answer why there may have been differences in the treatment of some dogs over others in the pre-colonial insular Caribbean.

Chapter Four outlines the methodology employed in this study. It includes an explanation of the utility and protocols for implementation of archaeozoological analytical techniques, such as determining mortality age profiles, morphological reconstructions, and investigating bone surface modification. The second portion of the chapter provides an overview of carbon, nitrogen and strontium isotope analysis, the protocol for their implementation, and discusses the ‘canine surrogacy method’ and previous isotopic research conducted in the region. It concludes by detailing how this empirical data generated by the aforementioned techniques will be combined with the ethnographic and ethnohistoric information from Chapter Two and ontological theory from Chapter Three to answer the research questions.

Chapter Five provides an overview of the two pre-colonial sites from which *Canis lupus familiaris* remains were analysed in this study, El Flaco and El Carril. It follows with an overview of the number of individual elements in the collection, the minimum number of individuals represented, the proportion of dog remains within the total faunal assemblages, and the archaeological context of these findings. It also provides an overview of the samples chosen for isotopic analysis as well as providing photographs of certain samples.

Chapter Six details the results of the archaeozoological analysis, detailing the morphological characteristics of reconstructed individual dogs where applicable, mortality age profiles, and an analysis of potential butchery evidence. It also provides the results from the isotopic assessment of the dental enamel and bone collagen samples chosen within this research and includes isotopic data from previously published resources (e.g. Hofman *et al., in prep.*; Laffoon 2017; Pestle 2010; Stokes 1998).

Chapter Seven discusses the results of this study, elucidating the husbandry practices and treatment of dogs by Amerindians at El Flaco and El Carril. This discussion incorporates perspectival theory, ethnographic analogy and ethnohistories to attempt to answer why a dualistic treatment of dogs existed within pre-colonial Amerindian societies in Hispaniola.

Chapter Eight consists of conclusive statements regarding the archaeological significance of the study and the applicability of employing a multi-disciplinary approach to develop a more holistic overview of human-animal relations. It also provides an assessment of the scope for further research.

Chapter Two: State of Affairs

2.1 The origins of the domestic dog (*Canis lupus familiaris*)

Canis lupus familiaris holds a unique position within the sphere of human-animal relations as our two species share the lengthiest history of social entanglement compared to any other domesticated animal (Russell 2011, 280). The genetic ancestor of the dog is the grey wolf (*Canis lupus lupus*) (Lindblad-Toh *et al.* 2005), which is theorised to have undergone a gradual process of domestication due to its behavioural and physical suitability for cooperation, commensalism and cohabitation with humans. A sharing of lifeways was likely influenced by the human desire for a hunting partner, protection from predatory animals or other human groups, and for companionship, eventually resulting in human control over the breeding and feeding behaviour of *Canis lupus lupus*¸ and gradually leading to phenotypical and genotypical transformations (Clutton-Brock 1995; Russell 2011; Zeder 2012).

Domesticated dogs became increasingly widespread approximately 14,000-9,000 years ago throughout southern and western Europe (Chaix 2000; Pionnier-Capitan *et al.* 2011; Vigne 2005), the Near East (Olsen 1985; Tchernov and Valla 1997), and the Eurasian steppe (Sablin and Khlopachev 2002). Although domesticated dogs became commonplace throughout Eurasia during the Late Pleistocene and Early Holocene, archaeological and genetic evidence indicates that human-canid relations may be of a lengthier antiquity, stretching back into the early Upper Palaeolithic. A canid cranium dating to approximately 33,000 BP from Razboinichya Cave in southern Siberia, Russia, exhibits features that are morphologically reminiscent of Neolithic dogs, although possessing certain features such as dentition that are more reminiscent of Late Pleistocene wolves. Ancient DNA analysis of this cranium determined its placement within a genetic lineage that was divergent from local wolf populations, possibly indicating that it belonged to an incipient dog undergoing a process of proto-domestication. The Razboinichya Cave specimen remains potentially the earliest evidence of dog domestication that has thus far been determined (Druzkhova *et al.* 2013; Freedman and Wayne 2017; Ovodov *et al.* 2011).

Although there is morphological evidence of diminutive canids from the Upper Palaeolithic reminiscent of later *C. familiaris*, genetic evidence indicating a continual ancestral lineage from this early period is currently unsubstantiated (Freedman and Wayne 2017). Genetic diversity in dogs has indubitably increased over time, so these early specimens, although morphologically distinct from grey wolf populations, can only tentatively be identified as domesticated dogs (Gemonpré *et al.* 2009; 2012). The temporal, biogeographical, osteometric and genetic variability in the evidences of early dog domestication suggest that there may have been multiple domestication events, with no one specific location within Eurasia serving as the likely origin of all later breeds of dogs (Larson *et al.* 2012).

Towards the beginning of the Holocene, with the advent of sedentism and incipient agriculture, dogs begin to appear within burials throughout the Near East (Clutton-Brock 1995; Olsen 1985). The Epi-Palaeolithic period (20,000-10,500 BP) is marked by regionally-specific cultural developments, seasonally-occupied settlements, the development of incipient agriculture, and evidence of increasing human-animal entanglements (Maher *et al.* 2011). The link between semi-sedentary lifestyle and the beginning of plant proto-domestication during the Epi-Palaeolithic is manifest in the Natufian culture of the Levant (Edwards 2015; Munro 2003). Several co-burials of humans and domesticated dogs have been recovered at Natufian settlements. Perhaps the most symbolically important Natufian dog burial comes from the site of Eynan (Ayn Mallaha) in modern day Israel, which covers a period of occupation spanning approximately 15,000-12,000 cal BP (Haklay and Gopher 2015; Perrot 1960). Burial H.104 from Eynan contains the articulated remains of an elderly man in a flexed position, with his left hand overlying a juvenile dog (Figure 1) (Valla 1975).

2.1.1 Canine psychopomps

Globally no other animal is found as frequently buried alongside humans (Clutton-Brock 1995). The beginning of the practice of dog burials marks a transition in human-dog relations from the solely utilitarian, stressing an incorporation of the dog into the metaphysical sphere, and representative of their value as companions in life and in death. This gesture is suggestive of the symbolic importance of dogs to people, meriting co-burial, and is indicative of an early perception of dogs as *psychopomps*; as guides and guardians of the deceased. The dog as a psychopomp is commonly repeated trope in ancient Indo-European folklore, and is mentioned in the Rig Veda, the Avesta, ancient Greek and Roman cosmologies (Berezkin 2014; Hansen 1987).

Figure 1: Burial H1.04 from Eynan: human male resting a left hand over the body of a juvenile domesticated dog (Valla 1975)

Similar metaphysical allocations of dogs as symbolic guardians and guides for the deceased are documented in the cultural practices of much of the pre-colonial Americas. In Peru, canine remains are found interred with Mochica human burials (Bourget 1994; Goepfert 2012), having been identified within a total of 15 tombs from Mochica tombs at the sites of Sipán, San José de Moro, Pacatnamú, and Moche. *C. familiaris* feature in complete burials or is often represented by the interment of certain individual elements, usually the skull or mandible. The ubiquitous internment of these animals as grave offerings, second only to endemic camelids, is suggestive of their role as guardians of the dead in Mochica cosmology (Goepfert 2012). Dichotomously, the presence of dog remains in domestic contexts at Moche may also suggest that they may have also been consumed by humans (Pozroski 1976; Vásquez Sánchez *et al.* 2003).

The symbolic nomination of *Canis lupus familiaris* as psychopomp is also a common trope in traditional Mesoamerican beliefs (De la Garza 2014). Within the K'iche' Maya *Popol Vuh*, the dog features as associated with death and the underworld, *Xibalba*, as well as mentioned as being as a source of food (Christenson 2007, 75). However, the ritual inhumation of dogs associated with human burials is a rarity in Mesoamerica, with most remains associated with human burials representing offerings of food to the deceased (Valadez Azúa *et al.* 2013, 577).

2.2 Introduction and spread of *Canis lupus familiaris* in the Americas

It is speculated that the arrival of dogs in the Americas coincided with the arrival of humans approximately 12,000 - 14,000 BP, at a time when the species was increasingly prevalent throughout Eurasia (Leonard *et al.* 2002). The earliest secure evidence in North America consist of three domestic dog burials dating to approximately 8,500 BP from the Koster site in the U.S. Midwest (Morey 2006; Morey and Wiant 1992). The appearance of *Canis lupus familiaris* in different regions of the Americas largely coincides with the emergence of sedentary agricultural communities (Larson *et al.* 2012). The earliest secure date of the appearance of dogs in Mesoamerica is demonstrated at Coxcatlan Cave, dating to 5,200 BP and synchronous with the development of settled agricultural communities in central Mexico (Flannery 1967).

The role of dogs in pre-colonial Mesoamerican societies ranged from companion, to food source, to sacrificial victim (Valadez Azúa *et al.* 2013, 558). Dogs feature prominently within the archaeological record of Mesoamerica, comprising of between 10 to 25% of all total identified animal remains throughout pre-colonial Mexican archaeological sites. A fifteen-year archaeozoological study of pre-colonial dog remains in Mexico resulted in the collection of over 100 near complete dog skeletons from ancient sites. Morphological analysis of these remains determined that there were at least five distinct pre-colonial Mexican dog breeds (Figure 2) (Valadez Azúa *et al.* 2013). At Teotihuacan,

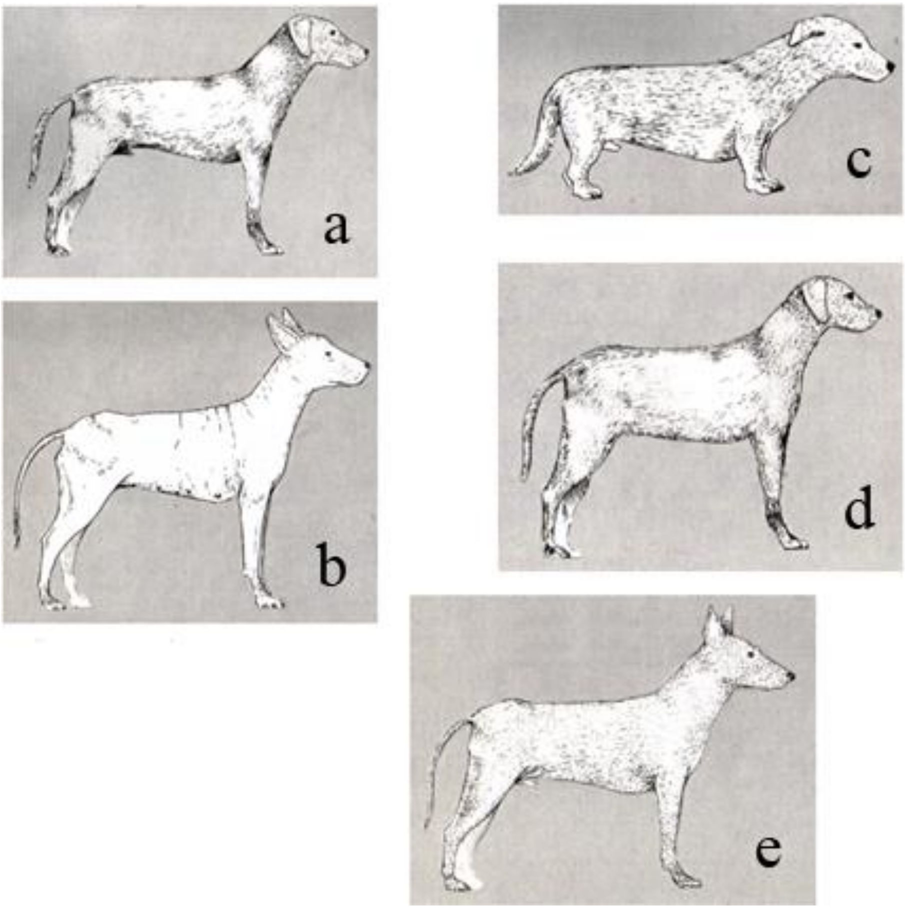


Figure 2: The five types or breeds of pre-colonial dogs from Mexico determined from morphometric analysis of faunal remains; a) common dog; b) hairless dog; c) *tlachichi* - short-legged dog; d) Maya dog; e) dog-wolf hybrid (after Valadez Azúa *et al.* 2013)

Guadalupe, Chaac Mool, and Tula, dog remains were interred as part of funerary and ritual purposes. Evidence of butchery and cooking indicates that dogs were also commonly consumed at the sites of Guadeloupe, Teotihuacan, and Zultepec-Tecoaque. The consumption of dogs is repeated throughout the Mesoamerican region, although often associated with religious and ritual feasting (Valadez Azúa *et al.* 2003). At the Postclassic Mayan site of Chaac Mool in Quintana Roo (c. AD 1100 - 1400), more than 30 juvenile canine skeletons were recovered, having likely been sacrificed and feasted upon as part of a Maya New Year ceremony (Blanco Padilla *et al.* 1999).

This association of the appearance of dogs with emergent sedentism in the Americas is a recurring pattern. This pattern is exemplified in the much earlier introduction of dogs into complex agricultural communities of the Andes around 3500 BP (Prates *et al.* 2010; Wing 1989), compared to their later introduction to most of lowland South America (Stahl 2003). In south-eastern Brazil, the earliest evidence of *C. familiaris* dates to 1701-1526 cal BP from the site of PSG-07 at Pontal da Barra (Guedes Milheira *et al.* 2016). In the southern reaches of South America, the earliest dogs are found in Argentinian Patagonia at the sites of Angostura I (938 ± 45 BP) and Chenque I (930 ± 30 BP), coinciding with the emergent sedentism and increased exposure to complex agricultural communities to the north (Prates *et al.* 2010).

2.3 *Canis lupus familiaris* in the pre-colonial insular Caribbean

The evidence from the insular Caribbean follows this pattern of the appearance of dogs in the archaeological record coinciding with the emergence of sedentism. Prior to the arrival of Arawakan-speaking sedentary agriculturists during the Early Ceramic Age (c. 500 BC- AD 500) (Rouse 1992), the Lesser Antilles were devoid of any terrestrial mammalian carnivores (Newsom and Wing 2004, 204). There are only two known animal domesticates in the region prior to the arrival of Europeans in the late 15th and early 16th centuries AD; the dog and the guinea pig (*Cavia porcellus*) (LeFebvre and deFrance 2012; Wing 1991; 2001). Archaeological evidence suggests that both animals were purposefully introduced and exchanged throughout the insular Caribbean during the early Ceramic Age (500 BC - AD 500) (Grouard *et al.* 2013; Kimura *et. al* 2016; Laffoon *et al.* 2014).

The earliest pre-colonial remains of dogs in the French West Indies are associated with Huecan Saladoid ceramics that date to approximately 500 BC (Grouard *et al.* 2013; Plomp 2013a). Within the Greater Antilles, the earliest dog remains are found at La Hueca-Sorcé and Punta Candelero in Puerto Rico associated with Huecoid ceramics (Crespo 1991; Narganes Storde 1982; 1985; Rodríguez 2007, 32-3; Wing 1991), with the earliest radiocarbon date being 201 ± 52 cal BC from Punta Candelero (Pestle 2010, 447). Prior to this there are no canine remains during an extensive human occupational history, which likely began around 6000 BC in Trinidad, and approximately 5000-4800 BP in the Greater Antillean islands of Hispaniola, Cuba, and Puerto Rico (Fitzpatrick 2011; Newsom and Wing 2004). Strontium analysis conducted on dog teeth from the sites of Morel and Anse à la Gourde in Guadeloupe provides evidence that *Canis lupus familiaris* was broadly exchanged between islands or migrated with people from elsewhere in the Lesser Antilles throughout the Early Ceramic Age (Laffoon *et al.* 2013; Plomp 2013a; 2013b).

The early instance of a dog burial at Punta Candelero dating to circa 200 BC, and the practice of interred dogs in Huecoid and Saladoid contexts in general, has raised interest about the possible multi-regional origins of dogs in the Caribbean. During this period, the practice of burying dogs was limited to northwestern South America, whilst contemporary evidence of dog burials from Oriniquoa, the proposed home of Saladoid peoples, is absent from the archaeological record (Rodríguez Ramos 2013, 164; Schwartz 1997). This raises questions about the likely geographic origins and direction of dispersal of dogs from the mainland into the insular Caribbean, but also the origins and influences towards the metaphysical rational governing the perceptions and treatments of dogs by humans in the region. It is likely that perceptions of dogs in the insular Caribbean are an amalgamation of multi-regional influences from various regions of the Americas, including northwestern and northeastern South America, the Isthmo-Columbian and Mesoamerican regions, and also local Antillean developments (Rodríguez Ramos 2013, 164-5).

2.3.1 *Canis lupus familiaris* burials in the Antilles

C. familiaris remains are commonly recovered from burial contexts throughout the insular Caribbean (Table 1) and are often buried in the same depositional contexts as humans but are also occasionally interred individually (Drewett 2004; Grouard 2001; *et al.* 2013; Hofman 1999; Hoogland and Hofman 2013; Newsom and Wing 2004; Wing 1991). The practice of burying dogs notably diminishes over time in the Lesser Antilles from the Early Ceramic Age (c. 500 BC - AD 500) to the Late Ceramic Age (AD 500 - 1500). This pattern is observed in Barbuda, and the French West Indian islands of Saint-Martin, Guadeloupe, and Martinique. On these islands the combined quantity of dog remains decreased from 24.3% of the total faunal assemblages during the Early Saladoid (500 BC - AD 500) to only 1.6% of the total assemblages during the Late Troumassoid (AD 1100 - 1500) (Grouard *et al.* 2013).

The site with the most numerous dog burials in the Greater Antilles is La Hueca-Sorcé on the Puerto Rican island of Vieques, in which 22 dog burials were found dating to the Early Ceramic Age (Wing 1991). Elsewhere in Puerto Rico they are found at Hacienda Grande (Walker 1985), Tibes, Aguacate and Punta Candelero (Crespo 1991; Pérez Merced 2000; Rodriguez 2007). In Cuba, at the sites of Birama, Cueva Bélica, Cueva de los Perros, Cueva de Pío Domingo and Corrales de Ojo del Toro (Fernández Ortega *et al.* 2006). In Jamaica, dog burials were recovered at the site of White Marl (Wing 1972). In Hispaniola, dog burials have been documented at En Bas Saline in Haiti, and El Carril, La Caleta, El Cabo San Rafael, Ramon Santana de San Pedro de Macoris and El Flaco in the Dominican Republic, all of which date to the Late Ceramic Age (Calderón 1985; Lawrence 1977; Newsom 1995; Rodríguez 2007; Shev *et al. forthcoming*; Veloz Maggiolo 1972). The presence of solo and communal human-canid burials throughout the region is suggestive of the symbolic importance that was placed on this animal by Amerindians.

2.3.2 Evidence of the consumption of dogs in the pre-colonial Caribbean

The utilitarian role of dogs as a source of food has not been thoroughly investigated archaeologically, and much of the evidence supporting the notion that dogs were consumed is inferred solely from archaeological context. Dog remains have been found in domestic or refuse contexts at several sites, including Anse à la Gourde in Guadeloupe, and El Cabo on the eastern coast of the Dominican Republic (Hofman and Hoogland 2015; Samson 2010). As it stands, there is only limited evidence from the insular Caribbean of bone surface modification to suggest that dogs were intentionally being butchered, although some remains from French Antillean and Barbudan assemblages demonstrate cut marks and are highly fractured. Although the finding of fractured bones within domestic or refuse contexts is not direct evidence of human consumption, some of these bones do however demonstrate evidence of scorching, which strengthens the hypothesis that some dogs were being consumed at these sites (

Figure 3) (Grouard *et al.* 2013).

The purported role of dogs in Amerindian societies is a contentious issue within Caribbean archaeology. Newsom and Wing (2004; Wing 2001) refute the notion that dogs were consumed in the pre-colonial Caribbean, seeing their role as an important, symbolically-loaded companion, stating the archaeological rarity for any solid evidence suggesting otherwise. However, as examples from elsewhere in the Americas have demonstrated, there is a greater regional precedence for dualistic treatment of dogs within pre-colonial Amerindian societies, with dogs commonly serving both as companions and as a source of food. Additionally, there may be some phenotypical similarities between dogs recorded in ethnohistoric sources and those found in Mesoamerica that are known to have been consumed by humans prior to the arrival of Europeans. In particularly, the lack of ability to bark, a trait purportedly shared with the endemic Mexican *xoloitzcuintli* and now extinct *tlalchichi* dog breeds (Valadez Azúa 2000; *et al.* 2003).

Figure 3: Right *Canis lupus familiaris* mandible (GMBT 1698 d us1008H2dec1) demonstrating intentional burning on the premolars and canine. Excavated from Early Saladoid (500 BC - AD 700) deposits at Gare-Maritime de Basse-Terre Basse-Terre, Guadeloupe (Grouard et al. 2013)

There is also the possibility of having existed two different dog breeds in the insular Caribbean. Sandrine Grouard and colleagues (2013) deduced from morphometric analysis that there are distinct differences in the Lesser Antilles between smaller canine individuals found in burials, compared to dogs recovered from refuse contexts, suggesting that there may have been more than one breed, with larger animals more subject to human predation. Grouard *et al.*'s (2013) study indicates that the larger type from Basse-Terre de Guadeloupe, La Désirade and Marie-Galante in Guadeloupe, Saint-Martin and Barbuda, weighed between 10-14 kg and possessed a shoulder height of 43-45 cm tall; whilst the smaller, dimunitive type found at Morel, Guadeloupe at at sites in the Dominican Republic weighed 5-10 kg and measured 35-40 cm tall at the shoulders. Geographical distance that would explain these differences in morphology as being the result of isolated populations is unlikely, especially since previous isotopic studies have demonstrated that there was a degree of mobility affecting dog populations from such sites as Morel and Anse à la Gourde in Guadeloupe (Laffoon *et al.* 2015). It is possible that if there were two breeds they may have served different functional roles within Amerindian societies.

2.3.3 Modified dog remains

Intentionally modified dog remains serve as testament to the symbolic importance of dogs to the indigenous peoples of the insular Caribbean. Carved canid skeletal remains have been recovered from Ceramic Age deposits, notably at Anse à la Gourde in Guadeloupe (Figure 4).

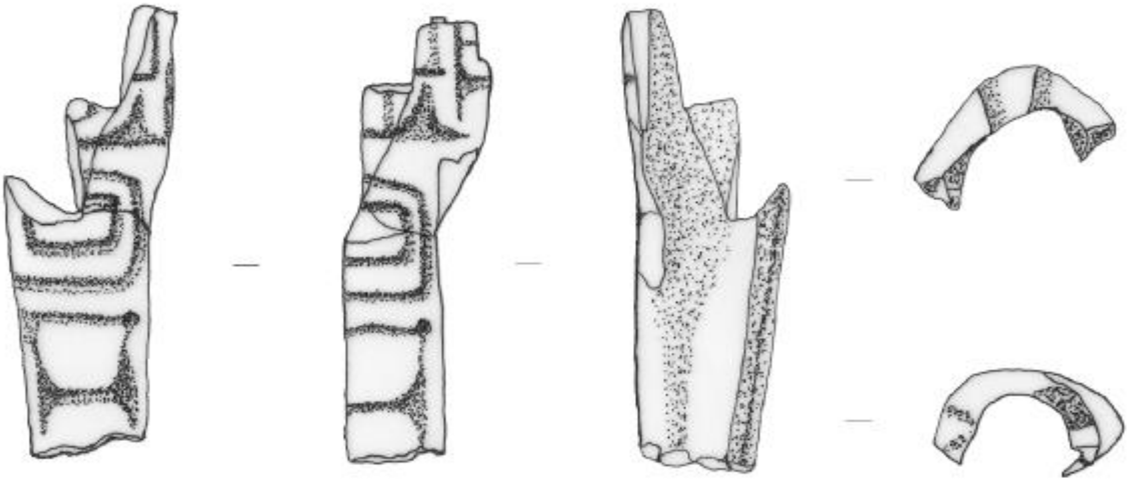


Figure 4: Incised patterning on a *Canis lupus familiaris* tibia recovered at Anse à la Gourde, Guadeloupe (Grouard 2001)

Findings of incised bone are limited compared to the prolificacy of modified *C. familiaris* teeth that have been recovered archaeologically. These teeth are often accompanied with perforations indicating their use as components of jewellery or are often found carved into pendants (Delpuech *et al.* 2002; Durand & Petitjean Roget 1991; *Grouard et al.* 2013; Ortega *et al.* 2006; Rimoli 1977; Roe 1995; Samson 2010; Wing 1991, 362). Within the site environs of the pre-colonial settlement of El Cabo in the eastern Dominican Republic were found a cache of approximately 3000 seal and dog teeth that contain incised Chicoid anthropomorphic motifs (Ortega 1978, 285). Additionally, within a posthole from the same site another similarly incised dog canine has been recovered (Samson 2010, 103-4, 207) (Figure 5).

Table 1: Known dog burials in the pre-colonial insular Caribbean

SITE	ISLAND	DATE	No.	W/ HUMANS	REFERENCE
Indian Creek	Antigua	Late Ceramic	—	Yes	Rouse and Morse 1999
Heywoods	Barbados	Late Ceramic	1	No	Drewett 1991; 2004, 221
Goddard	Barbados	Late Ceramic	1	No	Hackenberger 1991
Silver Sands	Barbados	—	7+	Yes	Drewett 1991; Wing 2008
Seaview (BA 016)	Barbuda	Early Ceramic	2	No	Perdikaris *et al.* 2008
Cueva Bélica	Cuba	—	50	—	Ortega *et al.* 2006
Cueva de los Perros	Cuba	—	—	—	Ortega *et al.* 2006
Cueva de Pío Domingo	Cuba	—	—	—	Ortega *et al.* 2006
Birama	Cuba	—	1	—	Ortega *et al.* 2006
Corrales do Ojo del Toro	Cuba	—	1	Yes	Ortega *et al.* 2006
El Carril de Valverde	Dominican Republic	AD 1200 — 1400	1	No	Lawrence 1977
Ramon Santana	Dominican Republic	—	—	No	Lawrence 1977
La Caleta	Dominican Republic	Late Ceramic	1	No	Rodríguez 2007
Boca del Soco	Dominican Republic	Late Ceramic	1+	—	Calderón 1985
Cabo san Rafael	Dominican Republic	—	—	—	Rodríguez 2007
El Flaco	Dominican Republic	AD 1200 — 1400	3	Yes	Shev *et al. forthcoming*
Morel, Grande Terre	Guadeloupe	300 BC — AD 1400	16	Yes	Hofman *et al.* 1999
Cathédrale, Basse-Terre	Guadeloupe	500 BC — AD 500	—	No	Bonnissent and Romon 2004
En Bas Saline	Haiti	Late Ceramic	1	—	Newsom 1995: 58
White Marl	Jamaica	Late Ceramic	1	—	Wing 1972
Vivé	Martinique	—	—		Mattioni and Bullen 1974
Trants	Montserrat	—	1	No	Petersen and Watters 1995
Sorcé-Vieques	Puerto Rico	Early Ceramic	22	Yes	Narganes Storde 1982; 1985; Wing 1991
Hacienda Grande	Puerto Rico	Early Ceramic	3	—	Walker 1985
Punta Candelero	Puerto Rico	Early Ceramic	6	No	Crespo 1991
Tibes	Puerto Rico	—	—	—	Crespo 1991; Pérez Merced 2000; Rodriguez 2007
Aguacate	Puerto Rico	Early Ceramic	1	No	Pérez Merced 2000
Hope Estate	Saint Martin	500 BC — AD 700	7	No	Grouard 2004

Necklaces comprised of perforated canines have been recovered throughout the Greater Antilles. One such example from a Dominican collection dated AD 350 - 1500 is constructed from 335 teeth, all containing homogenously designed incised lines located near the base of the crowns (Figure 6). (Montás *et al.* 1983). The most extravagant example is a necklace composed of 4000 canine teeth from Hispaniola (Rimolí 1977). Other examples recovered from the Dominican Republic include 28 decorated and perforated teeth recovered from Cueva Cabo San Rafael, La Altagracia, and 46 perforated teeth from Cueva de Guayacanes, San Pedro de Macoris (Ortega *et al.* 2006). These items may have served the purpose of a luxury wear, belonging to important persons within the political hierarchy of pre-colonial societies (Montás *et al.* 1985).

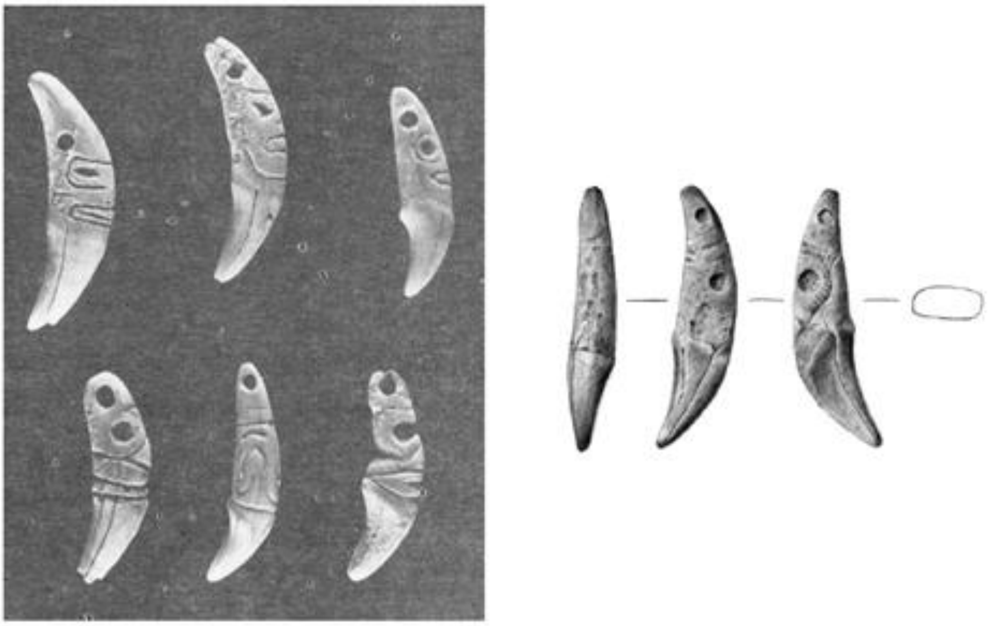


Figure 5: Perforated and incised dog teeth containing Chicoid anthropomorphic motifs. Left: photograph from a cache of dog teeth from near the site of El Cabo (Ortega 1978). Right: an incised tooth recovered from a posthole within El Cabo (Samson 2010, 104)

Figure 6: *Canis lupus familiaris* tooth necklace, from the collection housed at El Museo del Hombre Dominicano (Montás *et al.* 1983)

Animal teeth necklaces are commonly found throughout the South American lowlands, usually comprised of endemic fauna such as tapir and jaguar. However, a composition of dog teeth is unique to the pre-colonial cultures of the insular Caribbean. Peter Roe (1995) has theorised that the use of dog teeth served as a symbolic replacement for mainland fauna, with dogs serving as substitute apex predator, to be feared and respected. This implies a degree of cultural and ontological continuity with mainland cultures.

2.3.4 Artistic representations of *Canis lupus familiaris*

Depictions of dogs feature within the artistic repertoire of the pre-colonial Caribbean as ceramic *adornos*, petroglyphs, pendants and figurines. Pre-colonial dog figurines are made from a variety of materials including, bone, shell and lithics (Ortega *et al.* 2006). Notable examples include statuettes recovered from Sitio Macao (Morbán 1980, 102), and from an indigenous cemetery context at Constanza, both in the Dominican Republic (Krieger 1983). The most prolific representational forms of animals in the Caribbean are zoomorphic depictions on *adornos*, which are stylistically modelled lugs and handles of ceramic vessels (Moravetz 2005; Waldron 2010). Common zoomorphic depictions include an array of endemic animals, including bats, birds, turtles, frogs, dogs and other mammals. Within the insular Caribbean, *Canis lupus familiaris* is most prominently depicted on Saladoid-era adornos at sites in Guadeloupe, such as Morel and Gare Maritime, with dog motifs accounting for 19.3% (n=40) of all zoomorphic representations on adornos (Waldron 2010, 319). Depictions of dogs are easily identifiable due to their distinctive diagnostic features, commonly depicted in Saladoid and Huecoid ceramics in the Lesser Antilles as possessing a short, rounded head with prominently situated ears located on the top of the crania (Waldron 2010, 45, 121). A distinctive group of adornos, classified as dog effigies, are found in Early and Late Saladoid contexts in both Martinique and Puerto Rico, and are distinguished by their placement on vessels directly below the exterior rim of and on strap handles (Mattioni and Bullen 1974; Moravetz 1999, 197). In the Greater Antilles, dog adornos have been recovered from several sites. Of note are a multitude of dog adornos dating to the Early Ceramic Age were excavated from La Hueca-Sorcé, Vieques (Oliver 1999).

Of relevance to this study, the 2016 excavations at El Flaco revealed two ceramic adornos that share the characteristics of dog motifs found elsewhere throughout the insular Caribbean (Figure 7). The uncovering of these artefacts is suggestive of the totemic importance placed on dogs by Late Ceramic Age inhabitants of El Flaco and provides material evidence of the symbolic importance of dogs to feature as decorative motif for the inhabitants of this site.

Figure 7: Possible dog adornos recovered from excavations from the 2016 excavations at El Flaco a) FND 3284, Unit 84, frontal view; b) side view; c) FND 3101, Unit 71, frontal view; d) side view (photos courtesy of Corinne L. Hofman for NEXUS1492; Wauben 2018)

Several examples of carved petroglyphs and painted pictographs recorded at cave sites and Amerindian settlements in the Greater Antilles have been identified as depictions of dogs. Identifiable attributes denoting depictions of dogs include prominent ears, long legs, a large snout and a tail. Although there is often conjecture as to the accurate identification of specific taxa represented in often simplistic figurative petroglyphs, some of these images include all the above traits permitting accurate identifications, notably a petroglyph at Centro Ceremonial de Caguana in Puerto Rico, and cave paintings from Cueva del Hoyo de Sanabe (Figure 8b), and Cueva No. 1 del Pomier in the Dominican Republic (Figure 8c) (Oliver 1998, 134, 135; Ortega *et al.* 2006; Pagan Perdomo 1978).

The material evidence recovered from Ceramic Age archaeological sites in the Antilles is suggestive of the symbolic role dogs served to the indigenous peoples of the region. To grasp a better understanding of what precisely this role was, an examination of the ethnohistoric accounts of Amerindian lifeways, cosmologies and cultural traditions is needed. Although these accounts were often culturally biased, they provide the only historical reference of indigenous lifeways prior to the subsequent transformation of Amerindian cultural practices shortly after the beginning of European colonisation in the Americas.

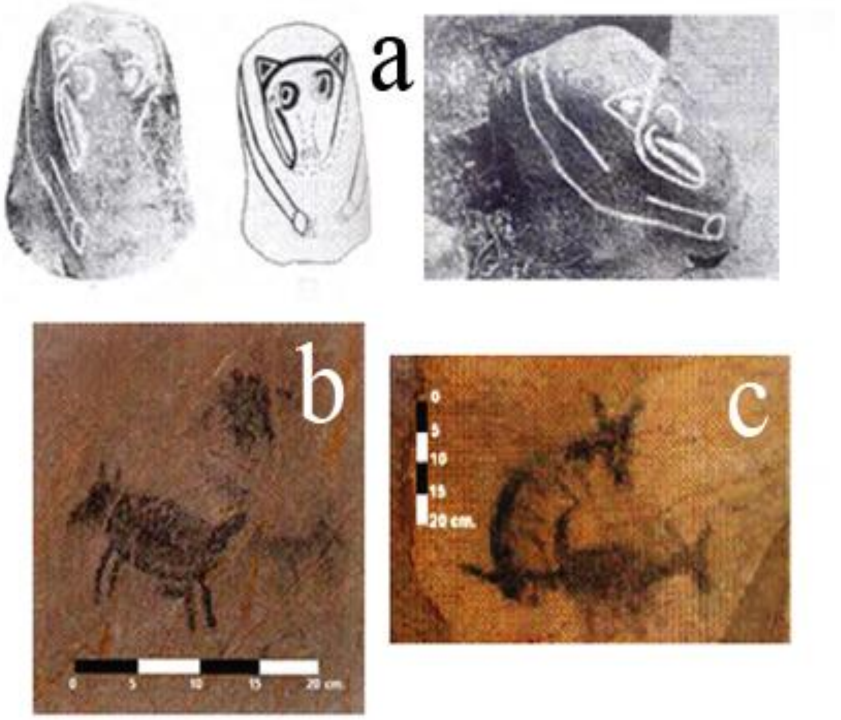


Figure 8: (a) Petroglyph from Plaza A, Centro Cermonial de Caguana Puerto Rico; left to right: frontal photo, frontal drawing, lateral photo (Oliver 1998); b) cave painting from Cueva del Hoyo de Sanabe, Dominican Republic (Ortega *et al.* 2006); c) pictograph depicting dogs copulating from Cueva No. 1 del Pomier, Dominican Republic (Pagán Perdomo 1978)

2.4 Ethnohistories

Rapid transformations in the cultural lifeways and ecologies of the Antillean islands occurred following the arrival of Europeans in the Americas. The island of Hispaniola in particularly became the incipient staging grounds for later European colonization of the Americas (Hofman et al. 2018). As the home to the so-called ‘Classic Taíno’ culture encountered by Columbus, the island of Hispaniola is long theorised to have been an epicentre of social complexity in the Greater Antilles (Curet 2003; Rouse 1992). However, because of the rapid cultural and ecological transformations that occurred as part of the ‘Columbian exchange’ (Crosby 1972), our historical understanding of indigenous lifeways and belief systems in the Antilles is restricted to a narrow chronological window.

Early European chroniclers often carried Eurocentric cultural and religious prejudices, recording the cultural practices of Amerindians as underdeveloped and idolatrous, and the people as noble savages living in ‘innocent purity’ and relative equilibrium with their environments (Allen 2010; Bartolomé de las Casas 1552 in Pagden 1992, 126; Lindberg 2013; Pané 1999). Even so, these ethnohistoric documents are the only records we have of the cultural institutions and worldviews of living indigenous communities during the initial cultural contact scenarios between Europeans and Amerindians. Ethnohistories provide documentation of the native dog breeds encountered by Europeans in the Caribbean, their functional role within Amerindian societies, and how dogs fit into the cosmological rationale of 'Taíno' peoples as a totemic symbol, codified within the religious practice of *cemíism* (Oliver 1997, 141). The following section discusses European encounters with dogs, their appearance and their utilitarian roles, followed by an examination of the anthropozoomorphic dog-deity *Opiyelguobirán* and what role this *cemí* served within the 'Taíno' belief system (Pané 1999).

2.4.1 Ethnohistoric accounts of native dog breeds

The notion that there may have been at least two separate breeds of pre-colonial dog in the Caribbean (Grouard 2001; *et al.* 2013), has some historical backing in early European accounts of the (Blick *et al.* 2016; Saunders 2005, 95-6). The earliest recorded description of native dog breeds in the Americas dates to 17 October 1492 during the first voyage of Christopher Columbus. Columbus' *diario* does not survive in its original form, however, an annotated version was included in the *Historia de las Indias* by Fray Bartolomé de Las Casas in 1559. The entry states that Columbus sent sailors ashore to obtain water on the newly discovered island of Fernandina in the Bahamas. His men reported back that the indigenous villagers possessed two different types of dogs that the Spanish described as *mastines* and *branchetes*. Las Casas records that *mastines* likely referred to mastiffs, although these dogs more closely resembled hounds, whereas *branchetes* (derived from French *'blanchete* - *blanc* "small and white") were smaller, terrier-like animals. It was noted that both dogs were incapable of barking, only possessing the ability to growl "…from inside their throats" (Blick et al. 2016; Columbus 1989 [1492]; Las Casas 1875a, 311, Capítulo 42). Las Casas, in his *Apologética Historia de las Indias*, describes some of the native dogs of Hispaniola as small, mute lap dogs (Las Casas 1909, 26, Capítulo 10).

Eleven days after this initial encounter, Columbus recorded discovering an abandoned fisherman's house on Cuba and coming across *un perro que nunca a ladro*- "a dog that does not bark" (Navarrete 1922, 48). On 6 November 1492 Columbus noted that on the island they did not encounter any "four-footed beasts… except dogs that did not bark" (Columbus 1989 [1492], 121). Las Casas (1875a, 319-320, Capítulo 44), further records that on the following day mute dogs were also encountered in a more populous nearby settlement. The presence of mute dogs is recorded by many of the earlier chroniclers in the Caribbean, suggesting that this may have been a common congenital trait for breeds in the region.

The ethnohistoric sources recorded that many of the dogs encountered by Europeans during the late 15th and early 16th centuries were actively consumed by the indigenous inhabitants of the islands. The practice of consuming dogs is accounted for by Peter Martyr d'Angheira, a member of the Council of the Indies. D'Angheira recorded in 1520 in his *First Decade* that Columbus encountered four ugly dogs on an island close to Cuba of a type which was regularly eaten by the indigenous peoples of the island (Mártir de Anglería 1892, 189, Capítulo 5). Another early 16th century account by Spanish clergyman Andrés Bernáldez notes that during Columbus' second voyage, on an island between Cuba and Jamaica the admiral encountered on a beach approximately forty small, mute dogs. These dogs were purportedly raised to be eaten by the Amerindians and were fattened up on a diet consisting predominantly of fish (Bernáldez 1856, 315, Capítulo 127).

Ethnohistoric accounts also describe how these dogs were used for other utilitarian purposes, in particularly for the hunting of a large endemic rodent, the *hutía* (Las Casas 1875b, 341, Capítulo 155; 430, Capítulo 170). There is contentious debate surrounding whether if two different breeds existed if they served distinct purposes, i.e. one for hunting and companionship, and the other as a source of food. It is possible that the *branchetes* described by Columbus were similar to European terriers in form and function, in that these smaller dogs were utilised for hunting small game such a hutía, rice rats and birds. It is these smaller statured dogs that were designated as *'aon'* by the native peoples of Hispaniola, who reportedly lavished them with affection (Las Casas 1929, 165). Similarly-sized dogs that likely served analogous utilitarian purposes are recorded from the circum-Caribbean, including in Florida, Honduras, Guatemala, Panama and Mexico, whilst the latterly located *tlalchichi* may have borne similar physical characteristics as the *aon* (Blick *et al.* 2016).

A more vivid description of pre-colonial dogs in the region is provided by Gonzalo Fernández de Oviedo y Valdés, official Chronicler of the Indies, describing their appearance in his *Historia General y Natural de las Indias.* Oviedo disclaims that the native dogs were extinct by the time of him writing this volume in 1536, however he describes their attributes from memory and first-hand accounts. Purportedly these animals were like European dogs in colour, being predominantly dun-coloured, white and brown, or occasionally spotted or mottled, but possessing comparatively rougher fur. The ears were upright, like that of a wolf, much as is observed in pre-colonial artistic representations throughout the Antilles. These dogs, like in other accounts, were noted as being physically incapable of barking (Oviedo y Valdés 1959, 30-31, Capítulo 5). In Capítulo 26 (Oviedo y Valdés 1946, 491) of the same volume describes their demeanour as placid and inactive, rarely doing much else than sleeping and eating.

A couple of 16th century European manuscripts provide pictorial depictions of the native dogs of the insular Caribbean that bear resemblance to Amerindian depictions and the ethnohistoric accounts. One such document, the *Manuscrito de Ferrara,* is an Italian compilation of letters, notes and accounts of the voyages of Columbus, Pinzón and other early European trans-Atlantic navigators (Martínez Villanueva 2015). This image is a depiction of what is labelled as *el perro mudo*, "*Aon*", in the manuscript (Figure 9a). Another chronicler, Luis Joseph Perguero, in his *Historia de la Conquista de*

Santo Domingo provides an illustration of these same dogs, additionally describing them as “similar to [Spanish dogs], but with a difference of being longer in the snout and with thicker feet and hands” (Figure 9b). These same animals he described as being mute that even when they were killed with sticks they did not bark or howl (Peguero 1975, 259 in Pagán Perdomo 1978, 76). The similarities in this depictions are largely associated with the short, stout limbs of the represented dogs, and the upright ears, these depictions also bear resemblance to rare endemic dog hairless dogs that still can be encountered in Curaçao (Figure 9c), and may be related to or remnant populations of pre-colonial dog breeds (*pers. comm*. Carel de Haseth to Corinne L. Hofman 2014).

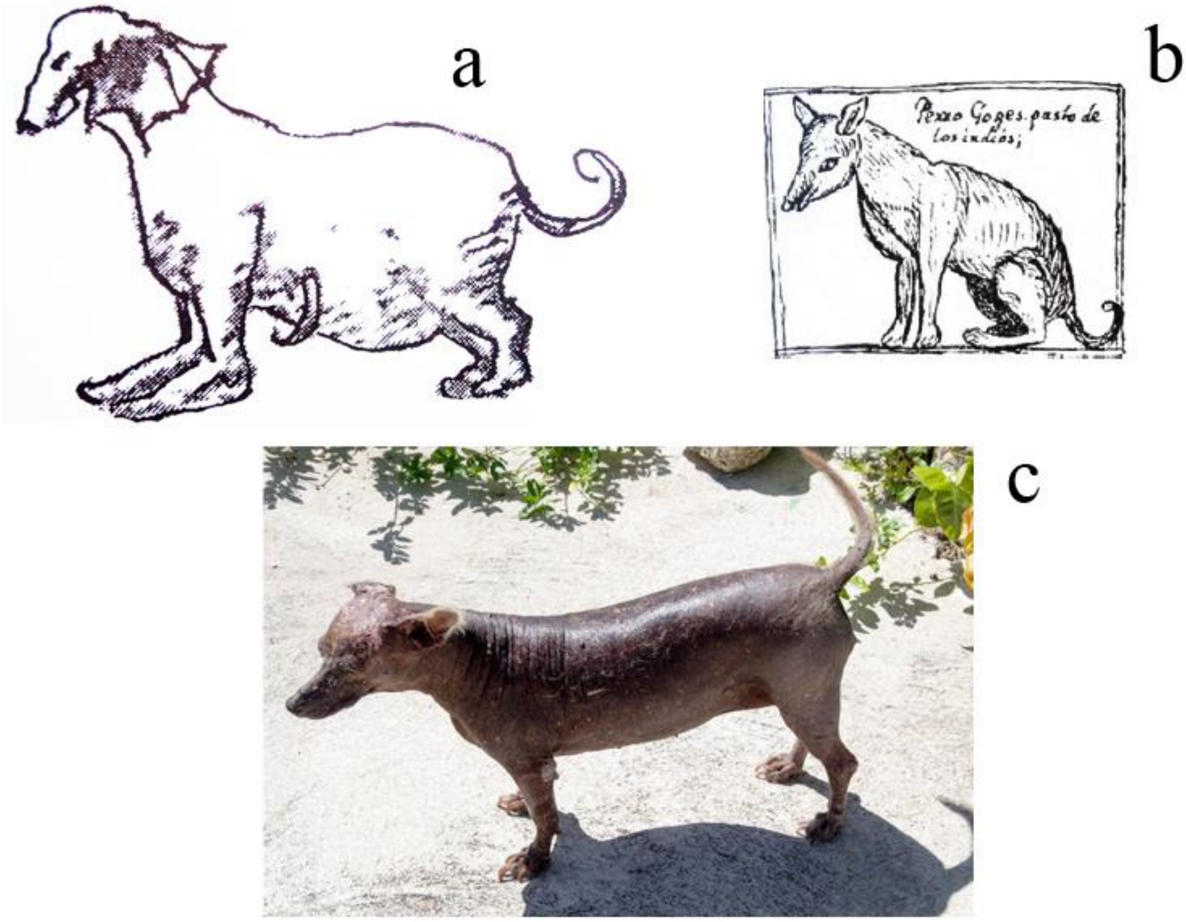


Figure 9: a) *perro mudo "Aon"* depicted in the Manuscrito de Ferrara (Martínez Villanueva 2015); b) illustration of the native mute dog by Luís Joseph Peguero (Peguero 1975, 259 in Pagán 1978, 76); c) photograph of a rare native hairless dog from Curacao (photo courtesy of Carel de Haseth, Curaçao via Corinne L. Hofman 2017)

2.4.2. *Opiyelguobirán*

Fray Ramón Pané’s *Account of the Antiquities of the Indians,* completed in 1498, provides the most informative account of the religious beliefs, traditions and language of the ‘Taíno’ peoples in Hispaniola. Pané accompanied Columbus on his second voyage, setting sail on September 25, 1493. In 1494 he had settled in the north of Hispaniola in the province purportedly belonging to the *cacique*

Mayobanex. Columbus subsequently ordered him to the land of Maguá ruled by Guarionex to "discover and understand the beliefs and idolatries of the Indians", it was there that he resided for several years, providing an eyewitness account of the religious practice of *cemíism* and recording aspects of the creation myths of the indigenous peoples of the island (Arrom in Pané 1999, xi-xiv)

Pane's account suggests that an animistic belief system was in practice by the 'Taíno' inhabitants of Hispaniola, which involved the worship of twelve distinct deities represented by idols (Pané 1999). Amerindian cosmologies of the Caribbean islands were likely educated by a potent interplay between antagonistic natural forces and states of order in the universe (Reichel-Dolmatoff 1976). To provide physical manifestations as aids for the appeasement of these chaotic forces, functional embodiments took form in the creation of *cemís* (Oliver 1997, 141). These *cemís* were physical representations of divine entities, each of which is representative of a "particular manner and superstition" to which homage was paid to. Taking form in a manner of different materials, including wood, ceramic and shell, a *cemí* was traditionally cared for by the *behique* of a village (Pané 1999, 3). Underpinning this cosmological rational of worshipping idols is the animistic belief in the transmutability of plants, animals and rocks, in which actors can take on different physical states while retaining originality in spirit. The result of this is that some *cemís* took the form of anthropozoomorphic figures, portrayed as neither fully human nor fully animal (Oliver 1997, 142).

One such *cemí* that held reverence for the indigenous peoples Hispaniola was *Opiyelguobirán*, the four-legged dog-like guide of the dead. *Opiyelguobirán*, in fitting with the animist notions of transmutation, took the form of a dog, and characteristically behaved as such (Oliver 2008, 185). Pané records in his *Account* the following:

> *"Concerning another cemí called Opiyelguobirán, which was in the possession of a preeminent man called Sabananiobabo, who had many subjects under his command. The cemí Opiyelguobirán has four feet, like a dog, they say, and is made of wood, and often at night he leaves the house and goes into the jungle. They went to look for him there, and when they brought him home they would tie him up with rope but he would return to the jungle. And they tell me that when the Christians arrived on the Island of Hispaniola, the cemí escaped and went into a lagoon; and they followed his tracks as far as the lagoon, but they never saw him again, nor did they hear anything about him..."* (Pané 1999, Capítulo XXII, 28).

Opiyelguobirán purportedly served the role of caretaker of the souls of the dead, known as *opía* in the 'Taíno' language. His role was to ensure that by sunrise every morning all *opía* were rightly returned from their night wanderings in the forest to Coabay, the island of spirits or land of the dead (Arrom 1989, 61; Oliver 2008, 183-4). The accounts of Las Casas, Pané and Columbus indicate that ancestor veneration was a prevalent religious practice for the 'Taíno'. Part of this belief is that *opía* frequently returned to the realm of the living at night, and for which communication with could be attained through shamanistic ritual involving the inhalation of the psychotropic plant cohoba (Arrom 1989, 109). For the ‘Taíno’, the dog held significance as the living manifestation of their guardian of the dead, *Opiyelguobirán*, therefore representationally providing the role of psychopomp. This aspect of the dog representing a supernatural guardian of the souls of the dead has been suggested as one possible reason for the co-burial of Saladoid peoples with dogs (Oliver 1999, 57).

The etymology of the name *Opiyelguobirán* provides further evidence of the role that this *cemí* served. *Opiyel-* is likely related to *opía*, a spirit of the dead, *-gu - gu[a]* is a possibly the pronominal prefix *wa*, meaning “our”, and *-obirán* is possibly related to the Arawakan Akawi word *Oroán* which pertains to “spirit of darkness” (Arrom in Pane 1999, 28; de Goeje 1928, 199). If this deconstruction is accurate, the name of this *cemí* would further indicate his rule as guardian of the spirits of the dead, undoubtedly serving an important role in the cosmological underpinnings of the ‘Taíno’ worldview.

2.5 Ethnographic analogies

Ethnohistoric accounts provide some evidence as to the treatment and perception of dogs by the indigenous peoples of the Antilles. However, as these records are limited to a narrow chronological window, and given their evident cultural biases, there is only subjective evidence from which to assume the exact functioning of human-canid relations in the pre-colonial Caribbean. For this reason, analogies provided by lowland South American ethnography provide another line of comparison that can help to discern the role of dogs within ‘Taíno’ society.

The use of this analogy must be made with caution, as although there are clear cultural and historical linkages between the two regions of the Americas, there is a real danger of essentialising the evidence to provide simplistic assumptions about human-animal relationships in the Caribbean. As a disclaimer, the use of ethnographic analogy for understanding Amerindian human-animal relations can only be made by arguing for a pan-Amerindian system of environmental perspectives that is only subject to minimal interference according to temporal distance and differences in cultural ecologies. The following information therefore argues that there is some merit in their being shared Amerindian cosmological perspectives as represented in mythos. However, the examination of the role of dogs in lowland South American societies cannot provide an exact replication of what was occurring in the pre-colonial Antilles and stands only as analogous information that can potentially aid in providing regionally-specific Amerindian examples of human-canid relationships. As an additional caveat, dog breeds from the insular Caribbean may have had multi-regional origins (Ramos Rodríguez 2013). Even so, the precise origins of dogs in the insular Caribbean has not yet been determined, and it is still likely that one of the main points of entry in to the region was from lowland South America.

2.5.1 Mainland - Antillean cultural and cosmological linkages

There are definitive cultural and historical linkages between lowland South America and the insular Caribbean as has been observed in shared languages, cosmovision, burial practices and settlement patterns. The emergence of the Saladoid culture during the Early Ceramic Age (c.500 BC) in the Antilles is thought to represent the migration of Arawakan peoples originating from the Orinoco River basin, who were the likely ancestors of pre-colonial and contact period ‘Taíno’ peoples (Heckenberger 2002; Rouse 1992; Siegel 1991). This linkage is based on a notable uniformity in artefact assemblages and a convergence of social and cosmological representations that form a continuum from Venezuela to Puerto Rico (Rouse 1992; Siegel 1989; Wilson 2007). Iconography on island Saladoid ceramics is shown to reflect their Amazonian origins (Roe 1989). Other cultural aspects, such as ritual interment indicate a linkable continuum with pre-Saladoid mainland South American cultures (Helms 2004, 126). Settlement structure has also been demonstrated to represent similarities, with the presence of circular village arrangements representing inherited perspectives of spatial functionality from lowland South America (Heckenberger and Peterson 1995; Siegel 2010). These historical and cultural linkage provide some justification for analyzing aspects of Amerindian cultures of lowland South America, in particularly in northern Amazonia, Orinoquia and the Guianas, to serve as possible conceptualizations of pre-colonial Amerindian lifeways in the Caribbean.

Within the material culture of Amazonia there are common representational forms that appear distributed throughout the region, suggesting that there is an inclusive pan-Amerindian cosmology marked by recurring symbols (Gomes 2012). Depictions of certain animals as ceramic figurines, on pottery and in other artistic forms appear commonly, such as large predatory cats and snakes that are reported in dreams and shamanistic hallucinations and hold largely transcendentally equivalent meanings cross-culturally (Roe 1982, 1-12). These forms of animal representation are also common in Wayana art, a Carib-speaking peoples from the Paru River, which Veltham (2003) claims are visual expressions representative of the cosmological universe. This common theme of representing great predators such as jaguars, snakes and birds of preys suggests the importance of depicting predators due to the inherent spiritual power that they embody. Gomes (2007; 2010) examined these representations of animals within Tapajônica ceramics, confirming the frequent representation of large predators such as alligators, jaguars and snakes, but also noted the depiction of prey animals such as agouti and paca. Viveiros de Castro (1998; 2002, 353) states that this selective representation is most commonly applied to predators who are considered enemies of humans, as well as occasionally to highly-revered select prey animals. Given the lack of large predators in the insular Caribbean it is theorized that the dog took up the mantle of the predator archetype within local cosmologies (Roe 1995).

According to Levi-Straus (1981, 619), a fundamental reoccurring concept in the mythology of the region is the belief in a primordial mythic age, sometimes portrayed in origin stories as a perpetual night or a perpetual day. It was during or at the end of this period that the emergence of mankind occurred, with varying stories working under a basic theme of the passage from a state of nature to a state of culture (Levi-Strauss 1981, 619). This is perhaps an oversimplification of the underlying themes, given the large number of variances within different origin myths to explain the emergence of culturally important and environmentally specific notions throughout the broad region of Amazonia. Although, even with these variations, it appears that this ‘mythic age’ is a common trope which within Amerindian cosmologies, denoting a time when cultural developments occurred that separated humankind from other animals (Gomes 2012; Liebenberg 2016).

A recognition of the past humanity of certain animals justifies enforcement of dietary rules that restrict the consumption of animals that are considered consubstantial in nature with humans. To consume animals that are regarded as such, shamanistic rituals governing reciprocity between humans and animals are often employed. Shamanistic rituals governing the consumption of certain animals that are attributed some aspect of humanity or personhood have been studied in the Bororo (Crocker 1985), the Muiname (Londoño Sulkin 2005), the Piaroa (Overing 1985, 1986), the Tukanoans (Århem 1993) and the Wari’ (Vilaça 1992) cultures, amongst others.

2.5.2 Ethnographic examples of the treatment of dogs in lowland South America

The presence of dog remains in pre-colonial archaeological contexts from Amazonia is rare, although this absence is possibly attributable to poor preservation conditions in Neotropical environments (Roosevelt 1989). However, this paucity of remains is not entirely suggestive of the lack of these animals in the region, particularly considering the utility of the animal as exemplified through their widespread usage as hunting dogs throughout the region today. Although, it is highly probable that many Amerindian peoples in the South American interior did not adopt the dog until the twentieth century (Koster 2014; Stahl 2012). For example, two Amerindian populations in the Brazilian Amazon, the Puruborá and the Karitiana did not encounter dogs until their introduction by Europeans in the 16th century (Velden 2017). There is however tentative linguistic evidence to suggest that there was a pre-colonial presence of dogs in the Orinoco basin and the Guianas, supported by the common native designation of dogs as “little jaguars”, suggesting a long-standing familiarity with the animal in this region (Schwartz 1997).

Due to the defined linguistic and historical linkages between the regions it is best to focus on ethnographies from geographical areas that pertain to common cultural origins with the indigenous people in the Caribbean islands, in particularly Arawakan and Cariban speaking peoples of Orinoquia and the Guianas. In proximity to the Orinoco basin in Venezuela, ethnographic sources have indicated the use of hunting dogs by the Panare (Henley 1982), the Hoti (Zent 1999), the Makiritare (Wilbert 1972), the Sanumá (Taylor 1974), the Yanomamö (Hames 1979) and the Wakuenai (Hill 1983); and in the Guianas by the Waiwái (Yde 1965), Trio (Rivière 1969), Wapishana (Henfrey 2002) and Warao (Heinen 1972). Some groups are well-renowned for breeding desirable hunting dog breeds, such as the Waiwái Cariban speakers of Guyana (Howard 2001, 248; Rivière 1963, 53).

This common usage of dogs as hunting companions is suggestive of their utility in the detection and chasing down of prey. Their capabilities in hunting prey animals are such that it been demonstrated that dogs help to increase the return rates for inexperienced or infirmed male hunters, making them highly valued in certain communities (Sugiyama and Chacon 2005, 248). The specific prey animals that are targeted when hunting with dogs varies according to local biogeographies. There has been suggestion that dogs are most useful for helping to detect and corral medium-sized rodents such as agouti (*Dasyprocta* spp.) and paca (*Cuniculus* spp.), although they are also likely to kill smaller prey independently when not trained or supervised properly (Cormier 2003, 115; Heinen 1972, 139; Kohn 2007). The behavioural characteristics of dogs affect their varied utility as good hunters, making them an asset while hunting collared peccaries (Koster 2009) but hamper efforts in hunting larger white-lipped peccaries and tapirs due to their propensity to scare off these animals before hunters can reach them (Cormier 2003, 49; Kaplan and Kopischke 1992, 99). The capabilities of dogs in being useful for hunting only certain types of prey may explain why they were not universally adopted everywhere in lowland South America as hunting aids, perhaps also explaining their archaeological paucity south of Orinoquia (Koster 2014).

Dichotomously, some types of animals that are considered pets in Amazonian societies are also targeted in hunting. Although this dichotomous treatment is largely seen as a taboo according to the Western perspective, this dual function as companion and prey is a common trope in Amerindian ontologies (Cormier 2003). However, there are certain rules governing these dichotomous relationships, for example the attainment of pets usually follows the adoption of an infant animal after its mother has been killed in a hunt. Likewise, once designated as a pet, these animals are rarely eaten (Crocker and Crocker 1994; Shepard 2002, Taylor 2001). The functioning of pet-keeping as oppositional to hunting has been interpreted as a method of social reproduction, or ecological reciprocity that governs the relationships between Amerindians and the environment (Cormier 2003; Erikson 2000). Phillipe Descola (1998) rejects this notion of keeping pets to counterbalance the negative effects of hunting activities, suggesting that the psychology of possessing a guilty conscience when killing animals is more likely a Western trait. However, cultural attitudes governing pet keeping unlikely affected the treatment of dogs as pets or as sources of food, whereas unlike other animals that are commonly kept as pets such as capuchin monkeys (Cormier 2003), dogs are entirely domesticated and therefore likely do not merit the same treatment as wild animals.

2.5.2.1 Preferential treatment of some dogs over others

There are indications in the Amerindian cultures of lowland South America of the preferential treatment of some dogs over others evident in their feeding regimes. In certain Amazonian communities, dogs are often malnourished and are forced to survive off refuse (Dumont and Hurlich 1981; Kohn 2007). Koster (2009, 589-590) notes the prevalence for dogs that were undervalued to live in poor conditions and in perpetual malnourishment in several Amerindian communities, including the Mehinaku, Juma, Cayapó of Brazil, the Yaruruos of Venezuela, and the Makushi of Guyana. However, concerning hunting dogs, the purposeful restriction of food has also been recorded as a technique for motivating these animals to be more aggressive and therefore more successful in the hunt (Carlin 2017, *pers comm*; Descola 1994, 231). Whereas in other examples dogs are given food that is prepared for human consumption, such as the feeding of manioc meal to highly valued hunting dogs by the Waiwái (Descola 1994, 231; Howard 2001, 243). There are even instances of highly valued dogs being fed meats that are considered taboo for human consumption (Sponsel 1981, 192). Preferential treatment is well documented with dogs in the region, with particularly good hunters receiving better care than other individuals who likely subsisted off scraps and refuse left by humans (Guppy 1954, Koster 2007, 128; 2009). The prevalence for preferential treatment of certain dogs over others in the South American lowlands, exemplified in the restriction of access to certain foods, raises the prospect of being able to assess the differential treatment of dogs from archaeological record of the Caribbean via the examination of their diets.

The consideration of hunting dogs as nonhuman persons and companions is apparent in the preferential treatment of these animals compared to their less-valued kin. Hunting dogs in Trio, Waiwái and Wayana communities of the Guianas are often tied up and sleep on dedicated raised wooden platforms to prevent them from suffering from parasites (Ahlbrink 1956, 46; Carlin 2017, *pers. comm*). Additionally, well-revered dogs are often carefully carried by Waiwái women down to the river to be cleaned (Carlin 2017, *pers comm*). The feeding of food prepared for human consumption to hunting dogs by the Waiwái (Descola 1994) is testament to the inclusion of this animal into the community at large.

The preferential treatment of dogs over other animals in South American communities is evidenced in their ritual burial in some communities. In some Waiwái communities on occasion dogs are imbued with enough symbolic importance to merit funerary rites, and in other instances dogs are buried with recently deceased peoples, affording protection and aid to humans in the afterlife (Fock 1963; Roth 1924). In northern lowland South America, ethnographic research suggests the preferencing of highly valued hunting dogs over other less useful dogs, and this is reflected linguistically in some Cariban and Arawakan lexica of the region.

2.5.3 Linguistic representations of dogs

There is some linguistic evidence to suggest a longer-standing relationship between humans and dogs in northern lowland South America. These linguistic similarities also serve as contextual evidence for the South American origins of insular Caribbean *Canis lupus familiaris*. This is evidenced in shared linguistic cognates in the word for "dog" in some of the indigenous languages of the two regions (Table 2) (de Goeje 1928).

Table 2: Cognates of the word for 'dog' in Amerindian languages from the northern South American lowlands (after de Goeje 1928)

Language	"dog"	Geographic area
Aruaco (Chichban)	*ualiro*	Colombia
Kalinago (Cariban)	*anli*	Lesser Antilles
Goajiro (Arawakan)	*er. guariz*	Northern Venezuela and Colombia
Paraujano (Arawakan)	*ieri*	Northern Venezuela and Colombia
'Taíno' (Arawakan)	*aon*	Greater Antilles
Achagua (Arawakan)	*auri*	Venezuela and Colombia
Maipure (Arawakan)	*auri*	Upper Orinoco
Piapoco (Arawakan)	*aouri*	Venezuela and Colombia

In the Cariban and Arawakan languages of the Guianas and northern South American lowlands there are some similarities between the word for dog and the word for jaguar (

Table 3). This notion that dogs are occasionally construed with jaguars, likely due to shared physical characteristics and predatory natures, supports the notion put forth by Peter Roe (1995) that the dog was the symbolic replacement for the jaguar in the Antilles. Additionally, the Waiwái, Wayana and Trio language discriminate in terminology between village dogs and hunting dogs, suggesting the special significance the latter has for these Cariban speakers (Carlin 2002; 2017, *pers. comm.*).

2.5.4 Traditional Amerindian stories involving dogs from northern lowland South America

Amerindian cultures in lowland South America often viewed the dog as a mediator between the spirit realm and the living, although it must be noted that there are few recorded narratives featuring dogs as a psychopomp, as is observed elsewhere in the Americas, including in Hispaniola in the form of *Opiyelguobirán*. The only narratives where dogs fulfil the role of guide of the dead comes from northern lowland South America, incidentally near the purported homeland of the pre-colonial Arawakan and Cariban speaking peoples of the insular Caribbean.

Table 3: Some Cariban and Arawakan terms for dogs. Note the occasional conjunctive term for 'dog' and ‘jaguar' and occurrences of different terms denoting the preferential treatment of hunting dogs over village dogs

Language	**Word**	**Meaning**	**Reference**
Lokono (Arawakan)	*peero* *dapeeron*	“my dog” “my dog”- inalienable possession. Borrowed from Spanish	Patte 2002, 89
Mawayana (Arawakan)	*jimaada*	“dog / jaguar” - interchangeable	Carlin 2017, pers. comm.
Wayana and Trio (Cariban)	*kaikui* *j-ekï* (*jeki*)	“jaguar” - also means ‘dog’ depending on the context and only refers to village dogs. Literally translates as “the one who grabs you” “my hunting dog” (*j* = ownership).	Carlin 2002, 63
Wayana (Cariban)	ëw-*ekï-kom*	“your pet” - denotes a relationship of mastery rather than direct ownership or property- reciprocal relationship (Carlin 2017 pers. comm)	Carlin 2002, 63
Waiwái (Cariban)	*Kamara* *Sa fari* *ijoku*	“jaguar” “village dog” - no possessive prefix possible “hunting dog”	Carlin 2017, pers. comm.

The Yukpa (Cariban) peoples of north-eastern Colombia mention that after death, a person’s soul must cross a large river or lake, for which a dog acts as a ferryman, judging those that have been cruel to dogs as either worthy or unworthy of passage (Villamañán 1982, 19-20; Wilbert 1974, 6). The related Metis ethnic group from the Aritama region of northern Colombia share similar beliefs, noting a black dog that transports deceased souls across a river of tears, followed by a white dog that carries a person across a river of milk, and finally, again by the black dog who ferries the deceased across a river of blood (Reichel-Dolmatoff and Reichel Dolmatoff 1961, 380).

Further to the east, De Goeje (1943, 12) reported on the Kalina and Taulipang (Cariban speakers), and Lokono (Arawakan) as having similar myths regarding a dog-spirit that awaits those after death. According to these beliefs, when a Kalina person dies he will reach a *pero-tamulu* or ‘dog-grandfather’, or Lokono *pero-oyo* ‘dog mother’, who will provide forgiveness to a confession of evil deeds to enable purification. The *pero-tamulu/oyo* will ask if a person has ever harmed a dog, if not the person’s spirit will be granted a gift, however if they have behaved malevolently towards dogs during their life they will receive nothing. In Kalina belief, should the deceased be judged meritously they will arrive at a river prior to reaching the settlement of the gods. This river is guarded by a large dog from whom the deceased need to pass to reach their destination (Ahlbrinck in Magaña 1987).

Koch-Grünberg (1923, 173-174) mentions a similar belief in the Taulipang (Cariban) cosmology, in which the souls of the dead travel east along the Milky Way to reach the dog spirit *aimalága-pódole* who gives judgement as to whether the person has harmed dogs in their lifetime. If they are favourably judged a person’s soul will be further guided onwards to reside in a large house with many other spirits, however should the outcome be negative other dog spirits known as *pero-tamula* will kill the offending spirit.

To understand how ethnographic information can be used as a basis for analysing the data obtained from the scientific methodologies employed in this study, an understanding of the theory behind pan-Amerindian cosmological rationales and environmental perspectives governing human-animal relations is needed. The following chapter provides some theoretical basis behind Amerindian perspectival thinking and examines the dog as an active agent affecting the behaviour and culture of people within Amerindian communities, as manifest in the practices of their keeping and in their symbolic placement within traditional belief systems.

Chapter Three: Animal agency and nonhuman persons from an indigenous perspective

3.1.1 Domestication and animal agency

Archaeological investigation has recently begun to focus on the role of animals within societies beyond solely the utilitarian. This social zooarchaeological approach incorporates notions that the treatment of animals varies according to their perceived value as nonhuman companions and as embodiments of symbolic thought (Hill 2013; see Russell 2011), which raises the question, do animals have an agential role in the structuring of human behaviour?

There is disagreement as to what the term 'agency' implies. In the field of developmental psychology agency is an early acquisition of mental concepts that beget intentionality in actions, whereas within biology, agency is oft explained as the ability for decision making manifest in an organism's ability for locomotion (Steward 2009). Within linguistics, there is a denial that any creature can possess intentional agency if it does not possess the ability for semantic communication (Davidson 2001). These definitions are focused on the physical and mental capabilities of organisms but are not necessarily helpful when discussing the emergent phenomena that arises in human-animal interactions. The recent anthropological interest in developing 'multispecies ethnographies' allows a multiplicity of ontological interpretations to be made, implying that the concept of 'being' is only manifest and emergent in relation to a myriad of 'multi-being' connections (Ogden *et al*. 2013). This implies that interactions between organisms change the behaviour of all parties involved during the process of forming a relationship, particularly relevant when analysing domestication as a human-animal entangled relationship.

Domestication can be defined as human control over the breeding and feeding regimes of certain animals (Bökönyi 1969, 219-20; 1989), an exertion of behavioural control and influencing of cultural transmission in animals (Clutton-Brock 1994, 28-30), or imposed ownership of animals by humans (Ingold 2000, 64). In opposition to a dominant-submissive relational paradigm, Frederick Zuener (1963) promoted the concept that human intentionality is largely possibly absent from domestication. For Zuener it is likely that domestication only occurred with certain animals that had previously scavenged around human settlements, such as pigs or dogs, or due to human parasitism on herd animals like sheep and goats. Domestication can also be defined as a symbiotic relationship between man and animal based on mutuality and commensality, therefore having evolutionary benefit for both animals in having their biological needs met (O'Connor 1997). This last approach works in recognition of animals having an active role in human-animal relationships, whether mutually beneficial or commensal, and provides more flexibility when examining relationships that are not strictly utilitarian (Russell 2011, 211-212).

In societies that do not practice animal domestication there appears to be a culturally-defined taxonomy that applies agency to only certain animals (Descola 2013). For example, in Eskimo cultures of the northern Pacific coasts of Chukotka and Alaska only certain prey animals such as marine mammals, reindeer and caribou are conceptualized as nonhuman persons and agents that possess the capability to decide when and how they react with humans (Hill 2011). However, such designations of personhood appear to be selectively applied by humans onto animals, so in this respect there is doubt as to how much intentional agency can be attributed to prey animals in hunter-gatherer cultures (Chiew 2014; Knight 2012). However, there remains the likelihood that any relationship shared between humans and animals, whether a predator-prey relationship or that of between humans and their domesticated animals, enforces a change of human behaviour according to the needs of the animal.

3.1.2 Archaeologies of entanglement

The investigation of human and nonhuman relational frameworks has become an important in interpreting past human behaviour, with some prevalent archaeological theory examining the observable entangled interactions between humans and nonhumans. Ian Hodder (2011a; 2011b) defines entanglement as the adoption of materials or organisms into a cultural complex that in turn enforces a reliance on those materials, plants and animals. Hodder’s entanglement implies that human behaviour is altered by the need to maintain, care for or acquire materials or animals that have become a necessary part of the operation of a society. For example, the domestication of the sheep, whilst allowing a constant source of food as well as other secondary products, entrapped Neolithic man into a reciprocal relationship between human and animal in which people out of necessity became shepherds (Sherrat 1981). Because of this entanglement, animals can be said to be performing a form of involuntary agency due to the necessary tending to of their physical requirements, resulting in human behavioural adaptations (Hodder 2011b). Therefore, a coevolution of the biological and social was necessitated by increasing reliance on particular animals. However, to focus on solely the utilitarian causal aspects of human-animal entanglements is limiting, as it fails to examine the psychological and metaphysical emergences that result from these interactions.

When discussing the dog and its long-standing role as an entangled domesticate, its functional utility, social role and influence on human decision-making cannot necessarily be as simply explained as that of the domestic sheep. Since the 1990s ‘social zooarchaeology’ approaches have attempted to identify the role of animals beyond the utilitarian by examining the complexity of human-animal relations manifest in symbology, companionship, sacrifice and denotations of wealth and prestige (Anderson and Boyle 1996; Plukowski 2005, 2012; Russell 2011). There is cross-cultural evidence that dogs are often highly revered and manifestly represented within the symbolic sphere of many societies (Hill 2013). Within the archaeological record, there is perhaps no more succinct evidence of complex interwoven social relationships between humans and nonhumans as examples of animal burials (Lindstrøm 2012), and cross-culturally dogs have been the most commonly ritually interred animal dating back at least 14,000 years (Benecke 1987; Hill 2013). This ritual inhumation serves as evidence of the intersubjective treatment of these animals in comparison to others, suggestive of their role not as being solely useful for hunting purposes or as pets, but as the emergent capacity of some dogs to achieve personhood and to be treated with the same ritual rites deserved of human members of a society (Losey *et al.* 2011). This application of personhood on dogs is not always so succinctly exemplified archaeologically as it is with instances of ritual interment. For this reason, it is important to employ a process of ontological refocussing, in other words to examine the indigenous perspective to understand how certain animals, i.e. dogs, fit into a people's relational worldview.

3.2 Animism and Amerindian perspectivism

3.2.1 The posthumanist turn- the Western perspective

Western Cartesian dualism affecting the conceptual separation of culture from nature is now being criticized within the field of anthropology. This is because binary nature-culture divisions are not a valid perspective in which to analyse the treatment of animals in cultures that possess contrasting ontologies to that of the dualist Western worldview. Bruno Latour saw this dichotomous perception of separation between man and nature as intellectually obstructive and viewed the productive success of modernity as being due to the proliferation of nature-culture hybrids that often go unrecognized in dualist, Western ontologies (DiNovelli-Lang 2013). Latour states "[t]he premoderns are all monists in the constitution of their nature-cultures." (Latour 1993, 41-42). According to Latour (1993) the term 'premoderns' is synonymous with indigenousness, with indigenous ontological understanding of nature and culture operating in oppositional frameworks to that of 'modernist' thinking.

Elucidations from the field of quantum physics have led to a philosophical challenge against the epistemological rationale underpinning dualist ontologies. For quantum physicist and feminist philosopher Karen Barad (2007), the idea of an imposed division of the human mind from nature is confounded by the systemic entanglement of all matter. Her promotion of a *posthumanist* approach serves as a poignant argument against the concept of human exceptionalism. Barad claims that there is quantifiable intra-activity between human observer and the observed, as demonstrated in the paradoxical outcomes of Thomas Young's wave-particle experiment, in which light was shown to act as both a particle and a wave depending on the method in which it was observed (Chiew 2014). Due to this entanglement of mind and matter there is no possibility for a purely human objectivity and Cartesian dualities; the existence of humankind is essentially an expression of the apparatus of life. She states that "[h]umans do not simply assemble different apparatuses for satisfying particular knowledge projects but are themselves specific parts of the world's ongoing reconfiguring" (Barad 2007, 184-5).

Barad's theory of agential realism is suggestive of a material world that in a constant state of becoming via interrelationships of interconnectivity (Alberti 2016). The recognition of an 'observer effect' in which human consciousness can affect the outcome of quantum experiments has led to the need to reassess how we interpret any materialist view of the world (Lyon 2016). As Barad (2007) suggests, any ontological approach that actively or passively denotes separation between humans and nonhumans is essentially incorrect, as there are inescapable linkages between the material and immaterial in the world, in a sense human culture *is* nature. Therefore, examining nonhuman agency is not about examining intentionality in nonhumans but rather the emergent interactions and effects that are implied by the convergence between nonhumans and humans. These recognitions of differences in viewing the nature-culture divide, or lack thereof, have had influence on the 'ontological-turn' that has enabled new approaches in investigating indigenous ecological perspectives for anthropologists and archaeologists working in the Americas.

3.2.1 Ontological turn

An ontological approach to interpreting archaeological findings has its roots in conceptual movements that occurred in the later 20th and early 21st centuries, heavily influenced by the 'new materialism' and 'new realism' conceptual movements (see Gabriel 2015). Notable pioneers of a relational approach in examining oppositional ontologies within the discipline of anthropology are Philippe Descola (2005), Bruno Latour (1993) and Eduardo Viveiros de Castro (1998), who each promote the concept that the binary distinctions between man and nature prevalent in Western thinking is only one ontology amongst many. In many ways an ontological approach is reliant on ethnographic analogies to formulate an understanding of the cosmological rationale of people from the past, in what has been labelled as an "anti-Cartesian" and a new relational approach to studying metaphysics in archaeology based on ethnographic information (Alberti 2016). These approaches critique Western notions of the monistic quality of nature and serve as a reaction to Western cosmological duality.

Fundamental to an ontological approach is the conception that anthropological inquiry that is epistemologically focused on the nature-culture divide will misrepresent non-Western perceptions of a relational ecology. According to Laura Rival (2014; 2016) the separation between plants, animals and humans can be dissolved, allowing a greater understanding of indigenous worldviews and relational understanding of the interconnection between humans and nature. Rival (1998; 2016) is largely focused on ethnobotanical studies educated by anthropological understandings of relational ecologies practiced by various indigenous groups in Amazonia. However, the majority of anthropological and archaeological focus has been on the relationship between humans and animals, with current leanings acknowledging cultural differentiation within the Americas but with suggestions of pan-Amerindian cosmological commonalities (Descola 2013, 17; Viveiros de Castro 1998).

3.2.2 Animism

Phillipe Descola (2013) provides a succinct reconfiguration of the terms ‘totemism’, ‘shamanism’ and ‘animism’ that often interplay within indigenous cosmologies. His concept of ‘animism’ is seen as a hierarchical system or relational ontology that is in opposition to Western ‘naturalism’. Descola (2013, 201) states that:

> *“[in naturalism] the universality of physicality extends its system to cover the contingencies of; in [animism] the generalization of interiority becomes a means of attenuating the effect of differences of physicality.”*

Animism is the perception that the internal spirits of humans, animals, plants or things take a generalized form, the only thing that separates all things is the physicality of existence, i.e. our bodies. Although Descola (1986; 2013) promotes his perception of Amerindian cultural unity underpinned by animist cosmologies, he acknowledges that this is not a case of Amerindian exceptionalism, pointing to evidence from across the Bering Strait in Siberia and South East Asia where animism also is a component of the worldview of hunter-gatherer societies. This notion of spiritual unity between man and nature appears to be primarily manifested among hunter-gatherer cultures that have a minimal reliance on domesticated plants and animals (Nadasdy 2007).

Even with a geographic spread of animism that extends beyond the Americas there is merit to assume that there are cosmological unities within Amerindian cultures. Descola (2013, 16) exemplifies this in discussing the Cree (Inuit) relationship of reciprocal exchange between humans and seals in which they hunt. Although there is a utilitarian need for hunting game which is essential for sustenance and continuation of humans, the Cree view the harpooning of seals as a cosmological necessity as the souls of harpooned seals are reborn into human children, and in the same note, once a person dies they may take the form of a seal. The commonality of the concept that animals share the ‘same stuff’ as humans and are essentially people in different bodies is best summed up by Sioux Indian theologian and Native American activist Vine Deloria Jr. (1973, 103):

> *“Behind the apparent kinship between animals, reptiles, birds, and human beings in the Indian way stands a great conception shared by a great majority of the tribes. Other living*

> *things are not regarded as insensitive species. Rather they are "peoples" in the same manner as the various tribes of men are peoples."*

The idea that animals can also be persons is pertinent in trying to understand the relational ontologies of Amerindian societies. Diverse notions as to what particular animals are applicable for personhood is evident throughout the Americas, as some animals are given significant privilege within the cultural taxonomies of different groups. Descola (2013, 342) notes how in Jívaro communities that only some animals and plants that are seen to share some ontological attributes with humans are attributed personhood via linkages of perceived consanguinity. It is therefore right in assuming that even though most life forms possess a soul in animism there is differentiation in what animals are designated as persons by humans, as in some cosmologies certain animals are perceived as lacking consciousness (Overing 1985, 249). In order to gain a better understanding of how this differential treatment can be manifested in Amerindian societies, Amerindian perspectivism provides a viable conceptual framework of interpretation.

3.2.3 Amerindian Perspectivism

In following an ontological reconfiguration of ethnological enquiry, Viveiros de Castro (1998; 2004; 2015) promotes the theoretical lens of 'Amerindian perspectivism' which shares many relational qualities with Descola's animism. He employs the term 'perspectivism' to denote a set of practices and ideas that share commonalities throughout the indigenous Americas. These cosmologies operate with the fundamental rationale that all creatures are nonhuman people in possession of a generic soul; a shared perception that can be termed as a 'phenomenological unity' (Viveiros de Castro 2004). Amerindian perspectivism has its formative roots in ethnographic evidence that suggests that Amerindian cosmologies do not feature a concept that differentiates animals from humans (Viveiros de Castro 2015, 226). Central to the perspectival quality of Amerindian thought is the idea that Amerindian cosmologies operate in an ontologically oppositional framework to that of Western nature-culture division (Århem 1993). As opposed to Western notions of the monistic quality of nature and multiculturalism, perspectivism implies that Amerindians viewed all life as existing within the same metaphysical 'culture' although expressed in different 'natures.' Amerindians see all living creatures in the world as possessing spiritual unity with one other but with corporeal diversity, leading Viveiros de Castro to coin the term 'multinaturalism.' This implication means that all animals see themselves as persons, although their perception of personhood and the taxonomic designation of other animals is dictated by their physicality, e.g. jaguars see other jaguars as humans, see humans as tapirs (a viable food source), or see human blood as manioc beer. What separates all living creatures is not their spirits, but their bodies as 'skins', this governs their perspectival qualities (Viveiros de Castro 1998). Central to Amerindian perspectivism is the recognition of recurrent mythic commonalities within different Amerindian cultures, with many origin stories sharing the concept a creational 'mythic age' in which animals were once humans that lost their culture, and in turn, humans gained culture (Liebenberg 2016).

Viveiros de Castro acknowledges that not all types of animal are applied with personhood or with spiritual importance, and there appears to be a hegemonic designation of animals within relative taxonomies as either consanguineous people, edible prey, feared and respected predators or untouchable spirits (Viveiros de Castro 1998; 2015, 204). There is notable emphasis of an animal's place in the food web and how it is perceived in terms of spiritual potency in Amerindian cosmologies, such as with the Makuna where the predatory point of view leads to the dominant paradigmatic classification of living beings as either 'eaters' or 'food' (Århem 1996, 188-9). In some cosmologies hunting and food acquisition is seen as an asymmetric mode of reciprocity between different animals, as is the case with the Yagua whom only hunt animals to 'restock' energy and compensate for losses caused by illness and death (Rival 2015). For this reason, personhood is usually applied to species that hold symbolic importance and a practical role for different cultures, such as a favoured prey species or great predators such as the jaguar (Viveiros de Castro 1998).

As aforementioned, the concept of 'animals' as separate from humans is not rendered linguistically in the region. For example, the Yawalapíti (Upper Xingu Arawakan speakers) use the term *apapalultapa-mina* as a designation for many creatures, the majority land-dwelling. This term is derived from *apapalultapa* (spirit) and *mina* (derivative designation of this class), implying that for the Yawalapíti regard all land mammals as "spirit-like" (Viveiros de Castro 1978). Their lack of ability in despiritualizing these animals means that they subsist mostly from fishing (Viveiros de Castro 2015, 227-8). In Huaorani language, *huao terero,* there are no words designating broad taxonomical terms such as 'animal', 'plant', 'nature' or 'ecology'. Abstract semiotic designations that denote separation of the mind from the body, or society from nature, are entirely missing from the *huao terero* lexicon. This appears to be a common semiotic trope throughout indigenous Amazonia (Rival 2012).

The attribution of personhood is also commonly seen throughout Amazonia in the cohabitation of humans with certain tamed animals such as peccary, tapir, paca, agouti, capybara and acouchi. Usually taken into societies after the killing of their parents during hunting, infant animals are often breastfed by women in certain communities and are viewed as pre-adolescent people who provide companionship for women and children. Because of the treatment of these animals as pre-adolescent people they are rarely allowed to reproduce themselves and are very rarely killed and eaten (Descola 2013, 379). In applying personhood to an animal there is also an attribution of conscious intentionality, which is embodied within the soul or spirit for which these nonhumans are thought to possess (Viveiros de Castro 2015, 244). This is contrary to Western perceptions of humanity's place within the domain of animality, as although we are biologically designated as such there is a practice of exclusionism against animals as Western thought perceives humanity also as a distinctly moral condition (Deloria 1973; Ingold 1991; 1994). In opposition to this, animist systems model nature after society (Århem 1996, 185), applying aspects of human intentionality and agency to animals, which under the framework of perspectivism form the backbone of the Amerindian cosmological praxis.

This designation of intentional agency is also embodied in the concept of caretaker 'spirit masters' for certain animals that are the subject of shamanistic rituals enforcing reciprocity between humans and animals (Viveiros de Castro 1998). This concept is found throughout Amerindian cosmologies and takes the form of shamanistic offerings that are used to develop a metaphysical alliance based on reciprocity and connivance with the spiritual embodiment of these animals, as is the case with the addressing of *anent* incantations by the Jívaro of Ecuador and Peru (Descola 2013, 342). There is however some merit to the argument that any notion of hunting as being a form reciprocity between humans and animals is merely imposed on animals, with co-sociality best observed not in a human-prey relationship, but rather a human-domesticate relationship (Knight 2012). It is perhaps within a co-social relationship as is evident in the tending of companion animals that perspectivism can best be employed to elucidate the cosmological rationale behind human-nonhuman entanglements. In utilising an ontological approach such as perspectivism as outlined by Viveiros de Castro, there is utility in disentangling cultural practices of people that could justifiably fit into this prescribed broad spectrum of Amerindian cosmological functioning. Perspectivism is not without its inconsistencies however, and as a result tends to suffer from criticisms of essentialising cultural differences and therefore being subject to notions of universalism.

3.2.4 Critiques of Amerindian perspectivism

The general totality implied by perspectivism has drawn criticism even from anthropologists that have applied some aspects of an ontological approach in their studies. The most notable and obvious critique of perspectivism is the overarching proposal of Amerindian phenomenological unity without taking into consideration multiregional variations. For this reason, the application of grand theories based on particular ethnographic examples has been criticised for implying universalism and cultural homogeneity (Ramos 2012). There is also founded criticism in the respect that perspectivism implies a totality of an integrated cosmological praxis that takes form in animist ontologies, disregarding the analogical and multiversal aspects of some Amerindian belief systems (Halbmayer 2012b). Ernst Halbmayer (2012a) has observed in Cariban speaking people's metaphysics the concept that there is no totality in existence, with an underlying belief in multiple forms of beings in a multiverse of co-existing worlds, Carib-speakers focus on multiple micro and macro-scale analogical correlations that cannot be entirely explained by the broad generalities embodied in perspectivism.

The oppositional nature of Amerindian multi-naturalism to Western naturalism has also been called into question. There is substantiated disagreement with the concept of promotion of an ontological “inversion” of Western naturalism, with arguments that the perspectival model cannot be wholly applied to all Amerindian cosmologies. The predilection for viewing animist ontologies as antithetical to Western scientific reasoning has been viewed as over-simplistic, rendering science as being solely predicated on binary distinctions between man and culture (Ramos 2012; Rival 2012). Laura Rival (2012) has criticised the assumption that Amerindian ontologies do represent an inversion of Western naturalism, arguing that the semiotic systems demonstrated in Huaorani mythologies is far more idiosyncratic than what is allowed for under a perspectival interpretational framework. For the Huaorani, animals were not ever humans, humans are the only true humans, and although linguistically there appears to be no separation between man and nature the designation of humans as predators and animals as prey is still a form of conceptual dualism (Rival 2012). This is contrary to the purpose of perspectivism, in which it is has been promoted as a way of applying a new post-structuralist ontological approach dispelling duality in nature and culture. Additionally, by implying that Amerindian ontologies are inverse in their treatments of the nature and culture divide is still referentially retaining these Cartesian dualities the approach is apparently trying to dispel.

A lack of epistemological strength in this approach is highlighted by one of the untestable central notions of perspectivism, that animals and humans perceive things differently and apply personhood on their own species within their own ontologies. Given that it is not possible to access the interiority of other animals, the perception of a jaguar viewing a human as a tapir or itself as a human can never be affirmed by asking a jaguar if that is how it views the universe. For this reason, the most succinct and clearest interpretations of the predator-prey relationships are still best educated by a naturalistic approach (Karadimas 2012).

3.3 Application of Amerindian perspectivism

Perspectivism has been criticised as dismissing scientific inquiry as overly simplistic and restrictively binary, as well as succumbing to overgeneralisations of cultural universalism operating in Amerindian cosmologies. However, Viveiros de Castro (2011) ascertains that the refocussing of anthropological inquiry by recognising Amerindian ontologies has the precise intention of calling into question the underlying motivations behind the discipline, being a study that places the *anthropos* at the centre. In acknowledging these criticisms, multi-naturalism is not an overarching description of a unified cosmology, but rather an approach that is reliant on acknowledging and commensurating differences within different Amerindian ontologies (Kohn 2015). The application of Amerindian perspectivism as a theoretical approach can allow for interpretations of imbued personhood on animals by understanding underlying tropes within Amerindian cosmologies. The theoretical approach embedded in perspectivism is to acknowledge the existence of different ways of viewing the entanglements between man and nature in a way that is distinct from our Western conception of nature. Within the archaeology of human-nonhuman entanglements it is therefore a viable approach in illuminating the possible cosmological rationale of Amerindian people, which is otherwise non-speculative from a limited archaeological material record. Central to this approach when particularly analysing the treatment and perception of dogs in pre-colonial Caribbean societies is an understanding of the relevant ethnologies from lowland South America, and an analysis of traditional ‘Taíno’ belief systems as recorded by ethnohistoric sources.

Given the limitations in a perspectival outlook, the employment of stable isotope ratio archaeozoological analyses aims to generate data that will provide empirical evidence of distinctions in the treatment of animals. These methods only provide the raw data, so any further interpretation in trying to understand the cultural and metaphysical rationales for why these differences in treatment have occurred is reliant on the use of analogies from lowland South American ethnographies, ethnohistoric accounts of ‘Taíno’ beliefs and treatment of dogs, and the incorporation of Amerindian perspectival theory. An attempt to understand *Canis lupus familiaris* as an agent, both physically and symbolically, is the only way to bridge the gap between *what* was the treatment of dogs in life and death as observed from the scientific methodologies and attempting to understand *why* a certain treatment was conferred on this non-human animal in the pre-colonial insular Caribbean.

The following Chapter Four outlines the methodologies that were employed in the qualitative archaeozoological and multi-isotopic analyses of *C. familiaris* remains from the sites of El Flaco and El Carril, and the collagen isotope analysis of the dog remains from the three Lesser Antillean sites. It also illustrates the scientific underpinnings and rationale for the employment of analytical techniques from archaeozoological and isotope ratio analysis methodologies. This chapter is structured to provide a systematic outline of the procedures that were implemented in the analysis of *C. familiaris* remains in this research.

Chapter Four: Methodology

4.1 Outline of methodology

This study combines archaeozoological and multi-isotope analyses to provide an empirical assessment of the treatment of dogs at the pre-colonial settlements of El Flaco and El Carril. Archaeozoological analysis can help reconstruct the morphological characteristics of these animals, patterns of age-related mortality, and if there is any evidence of peri-mortem manipulation of dog remains as evidenced by butchery marks, fracture patterns or signs of cooking. This information will be used to assess the animal management practices of Amerindians affecting the treatment of dogs and provides empirical evidence to assess whether certain individual animals were being consumed by humans. The multi-isotopic analysis of dog remains from the two sites of El Flaco and El Carril elucidates their geographical origins and allows assessments of the dietary regimes of these animals. This information can determine whether there is evidence of similarities with human dietary signatures from El Flaco, and in turn indicate human-influenced feeding regimes, commensality, or scavenging activity (Guiry 2012). Strontium isotope analysis of the same teeth will help determine if the remains of these dogs were locally raised, and when combined with dietary reconstructions, if there are regional distinctions in diet.

To develop an understanding of the cultural motivations and metaphysical reasoning dictating these modes of treatment, analogies from ethnographic studies in Amazonia, and early ethnohistorical documentations of dogs within the Caribbean, as discussed in Chapter Two, will be utilised. Amerindian perspectivism, as is discussed in Chapter Three, will be employed as a theoretical tool for assessing the ontologies of indigenous peoples in the Caribbean, in particularly in assessing the rationale behind why certain individuals were treated differently and possibly consumed by humans, compared to others who were imbued with personhood as evident in their ritual inhumation.

4.2 Archaeozoological analyses

This section provides an overview of each of the archaeozoological analytical techniques that are employed in this study, the research underpinning their utility for employment, and the advantages and limitations of each. This will be followed by protocols of implementation of these techniques for the analysis of *Canis lupus familiaris* remains from the pre-colonial sites of El Flaco and El Carril. The techniques utilised in this study involve osteometric analysis and observations of developmental maturity to reconstruct morphologies and estimate mortality ages respectively. Observations of bone surface modification were also made to establish if there is anthropogenic manipulation of dog remains at the discussed sites.

4.2.1 Determining age from epiphyseal fusion and dental eruption

The assessment of mortality profiles of the dogs recovered from the two sites is indicative of domestic practices affecting the treatment of these animals. Establishing mortality profiles are useful in examining hunting practices (see Brugal and David, 1993; Fernandez et al., 2006; Klein, 1982; Stiner, 1990) and herding strategies (see Halstead, 1998; Marom and Bar-Oz, 2009; Payne, 1973). Two commonly deduced mortality profiles can be established by investigating the age of death of an animal community, that which corresponds to a stable living structure known as a ‘catastrophic’ profile, and that which indicates elevated levels of juvenile or subadult individuals and older individuals known as an ‘attritional’ age profile (Discamps and Costmango 2015). Catastrophic profiles are associated with natural disasters, untargeted hunting strategies or mass kills (Costamagno 2003; et al., 2006; Hill et al., 2008; Klein, 1978, 1981; Levine, 1983; Lyman 1987; Reher, 1970; Rendu et al., 2012; Stiner, 1990). Attritional profiles are often associated with the effects of disease, malnutrition and predation and scavenging (Clutton-Brock et al., 1982; Stiner, 1991), or if associated with husbandry practices can serve as an indication that meat production was a secondary concern (Caughley 1966). Another relevant mortality profile is the “carnivorous husbandry” model, which is similar to attritional models but exhibits spike in the mortality of newly matured breeding age males. Carnivorous husbandry models are often associated with the keeping of certain domesticated animals that are not cost-effective in raising solely for meat, such as cattle or horses (Levine 1983, 29).

Two techniques commonly used for age determination are tooth eruption and epiphyseal fusion analyses. Tooth eruption rates measured in several domestic breeds of dogs, as well as Eurasian grey wolf (*Canis lupus lupus*), demonstrate consistent rates of development. The limitations lie in that generally most breeds of domestic dogs reach dental maturity after five months of age (Geiger *et al.* 2016), rendering any estimation of ages over five months impossible if only isolated teeth are analysed. Epiphyseal fusion, or the ossification of the articulation ends of a bone, is much less reliable as a proxy for estimating age and should be used with caution since only a general estimation of age range can be given (Sumner-Smith 1966). Even so, the study of epiphyseal fusion has its merits in allowing general assumptions concerning the mortality age of an individual, particularly since it allows age estimations older than what is possible by studying dental eruption alone.

4.2.2 Age estimations based on tooth eruption

A study by Geiger *et al.* (2016) was conducted to ascertain if there are any distinguishable differences between breeds of domestic dog and *Canis lupus lupus*. This research investigated the timing of dental maturity of 137 domestic dogs from 15 breeds, alongside 64 wolves. The study only implemented animals that were under the age of 14 months, given that domestic dogs are generally developmentally mature after one year (Hawthorne *et al.* 2004). Geiger *et al.*’s (2016) study concluded that in both wolves and domestic dogs, full dental maturity is usually reached within 4-6 months of development. Due to the unknown genetic lineage of the dogs sampled from El Carril and El Flaco, general ranges taken from Geiger *et al.*’s study were utilised as an indication of the potential ages of the studied specimens. The ranges of potential adult tooth eruption are outlined in Table 4.

Table 4: Dental eruption ages of several breeds of dogs (after Geiger *et al.* 2016)

Lower Jaw	**months**	**Upper Jaw**	**months**
I1	3.2 - 5	I1	3.2 - 5
I2	3.2 - 5	I2	3.2 - 5
I3	4 - 5	I3	3.6 - 5
P1	3.2 - 5	P1	3 - 5
P2	4 - 5	P2	4 - 5
P3	4 - 5	P3	4 - 5
P4	4 - 5	P4	4 - 5
M1	3.2 - 5	M1	4 - 5
M2	4 - 5	M2	4 - 5
M3	4 - 5		

4.2.1.2 Establishing age estimations from epiphyseal fusion

Another method of determining the mortality profile is the examination of bone fusion in the ossification centres of epiphyses. Epiphyseal fusion can give an indication of a relative age range, with the caveat that there are observably varied rates of development between dogs from the same litter and breed, and considerably marked inter-breed differences (Sumner-Smith 1966). Radiographic studies of epiphyseal fusion in dogs have been conducted by Bateman (1952), Turnbull (1952), and Schlotthauer and Janes (1952) and Hare (1959; 1960). Sumner-Smith’s (1966) study involved the largest sample of radiographed long bones and podia, taken from two source populations (Table 5). The studied sample indicated varying rates of ossification, both inter- and intra-breed, however a general sequential order of epiphyseal fusion was observed. No one breed indicated consistently earlier ossification than others. For these reasons employment of epiphyseal fusion ranges only provides rough estimations of mortality age.

Table 5: Epiphyseal fusion rates of long bones as determined from radiography (after Sumner-Smith 1966)

Hind limb		**Fore limb**	
Middle phalanx	16w - 5m	Middle phalanx	16w - 5m
Proximal phalanx	16w - 7m	Proximal phalanx	16w - 5m
Metatarsal	5m - 7m	Metacarpal	5m - 7m
Calcaneal tuber	11w - 7m	Carpalia	10w - 5m
Distal fibula	5m - 8m	Distal ulna	6m - 8m
Distal tibia	5m - 8m	Distal radius	6m - 9m
Proximal fibula	6m - 10m	Proximal radius	5m - 8m
Proximal tibia	6m - 11m	Proximal ulna	5m - 8m
Distal femur	6m - 8m	Distal humerus	5m - 8m
Lesser trochanter	9m - 10m	Proximal humerus	10m - 10m
Proximal femur	6m - 9m	Scapular tuberosity	12w - 5m
Greater trochanter	6m - 9m		

4.2.1.3 Protocol for determining mortality age

Geiger *et al.*'s (2016) method for estimating tooth eruption ages, and Sumner-Smith's (1966) method of determining epiphyseal fusion ages were employed in this study. The age ranges ascertained from the aforementioned studies allowed an estimation of the potential mortality ages of dog specimens for this research. However, given the lack of knowledge regarding the ontogenic characteristics pre-colonial dog breeds from the insular Caribbean, this information must be used with caution, hence why only estimations are applicable rather than exact deductions based on proxy representative modern breeds. Calculations of age of death will allow inference of mortality profiles, indicative of modes of domestic management that were occurring with dogs at the two sites. The protocol for determining mortality age from *Canis lupus familiaris* dental profiles is listed below:

1. All teeth, whether loose or as part of a maxilla or mandible are identified.
2. Determinations of dental eruption are made on all mandibles and maxilla that contain teeth, or the empty sockets of adult teeth that indicate eruption had occurred. Only loose adult teeth that possess both root and crown are determined to be fully formed and likely became displaced from the jaw.
3. Using Geiger *et al.*'s (2016) study, age estimations will be made according to the most recent erupted tooth in a tooth row. Loose teeth will be aged on their designated eruption age. Age estimations from teeth only provide the youngest possible age at death.

Analysis of epiphyseal fusion in appendicular elements provide age estimations ranging from 5 months of age to a maximum of 12 months of age when dogs achieve full skeletal maturity. The protocol for determining mortality age from epiphyseal fusion of dog bones is as follows:

1. All complete appendicular skeletal elements are identified.
2. Observations are made according to the degree of epiphyseal fusion that has occurred on all appendicular elements that exhibit at least one epiphysis. Both the proximal end and distal end of long bones are analysed as they exhibit different rates of ossification. One of three designations are made as to the level of ossification:
    a. Unfused - The epiphysis is missing from the rest of the shaft and has not been fractured off.
    b. Partially fused - Ossification is not complete due to the porous nature of bone, or if the joining between the diaphysis and epiphysis is not wholly fused but still attached.
    c. Fused - Ossification is complete and there little to no observable signs of continual fusion.
3. Age estimations are made according to data from Sumner-Smith (1966). Unfused elements indicate that the age of fusion has not been reached. Partially fused elements give higher accuracy as to the mortality age of individuals by providing more exact age ranges. Individuals represented by more than one skeletal element are designated the age of the latest occurring epiphyseal fusion.

For the ease of data analysis in this study, the designation of juvenile status is set at under 5 months of age before dental eruption is complete. Subadult individuals fall under the category of between dental maturity and the completion of epiphyseal ossification at between 5-12 months of age, whereas definitively adult individuals are aged over 12 months. As the dental eruption and epiphyseal fusion rates of dogs are of a much shorter time range than many other domesticated animals, estimations of an age exceeding the maximum designation of 12 months of age are untenable.

4.2.2 Conducting size estimations from morphometrics

Morphometric analysis provides information as to the relative size of dogs in relation to extant breeds and archaeological examples from elsewhere in the pre-colonial Caribbean. Assessing the size of individuals from the studied sites allows assumptions to be made as to whether there was more than one breed of pre-colonial dogs, and whether there is a relation to size and the treatment of certain individuals. Information that can be garnered from morphometric data include the development of relative indices, potential live weight and estimations of shoulder height (Anyonge 1993; Clark 1995; Clark 1997a; 1997b; Forest 1997; Harcourt 1974; Wroe et al. 1999). These techniques are most useful when there is an archaeological baseline of dog morphologies that are spatio-temporally comparable. Grouard *et al.*'s. (2013) study on pre-colonial dog burials throughout much of the Lesser Antilles and Hispaniola provides a comparative baseline for assessing the size of individual dog burials both from the Dominican Republic and other sites throughout the Antilles. Estimations of size were undertaken on dog burials from Cathédrale de Basse-Terre (n=1), Gare Maritime (n=3), and Morel (n=8) in Guadeloupe, Seaview in Barbuda (n=3), and the Dominican Republic (n=5), the latter from Lawrence's (1977) study of dogs from archaeological sites. This data serves as a comparative baseline for assessing the relative sizes of dogs from El Carril and El Flaco.

4.2.3 Shoulder height

Of all techniques of size estimation, shoulder height (SH) (Figure 10) has the most utility in expressing the visual characteristics of dogs and assessing variability in size (Clark 1995; Daza Perea 2017). Reliable estimations of shoulder height can be ascertained from the study of long bone length (Harcourt 1974), metapodia length (Clark 1995), and cranial dimensions (Chrószcz *et al.* 2007). The aforementioned studies derived shoulder height estimations using regression formulas determined against known dependent values. Harcourt (1974) utilised regression equations formulated by the study of 34 dogs of known shoulder height, examining the relationship between shoulder height and long bone length. Clark (1995) calculated the SH of fifteen modern dog skeletons from metapodia length, determining a high correlation coefficient (r^2 = >98%) with shoulder height calculated from long bones using Harcourt's (1974) formulae. Clark studied metacarpals II-V and metatarsals II-V, allowing the formulation of factors to accurately estimate SH from the greatest length (GL) of these elements. Cranial shape and size has also been demonstrated to have a correlation to the size of long bones in dogs (Alpak *et al.* 2004). As originally outlined by Wyrost and Kucharczyk (1967) and further demonstrated by Chrószcz (*et al.* 2007), estimation of SH can be achieved by measuring the internal dimension of the cranial cavity. Tested on 91 dogs of various breeds and all crania type, i.e. dolichocephalic, mesocephalic and brachycephalic, this method demonstrated a positive correlation coefficient (r = 96.1%) with the known shoulder heights from the same individuals (Chrószcz *et al.* 2007).

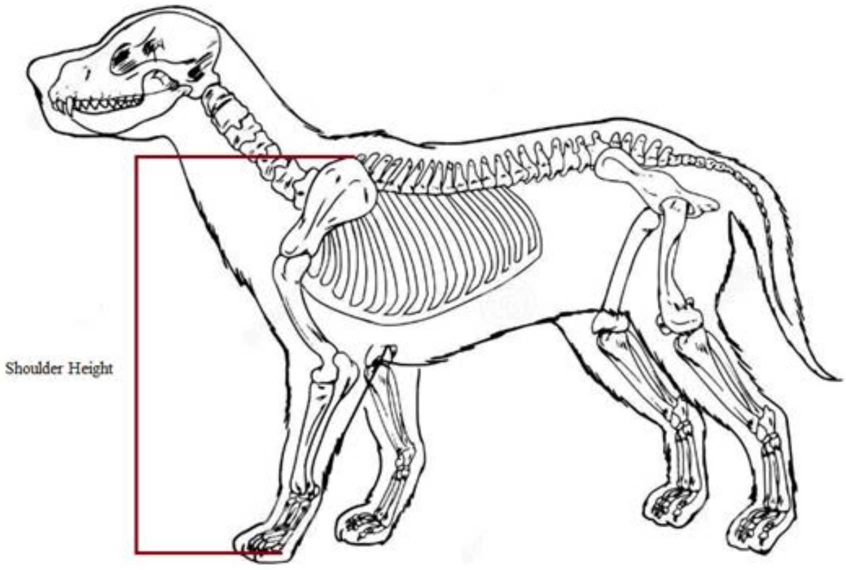


Figure 10: Diagram demonstrating shoulder height in relation to the overall size of *Canis lupus familiaris*

4.2.3.1 Protocol for determining shoulder height from long bone measurements

1. To calculate SH, the greatest length (GL) of each complete long bone is measured in millimetres (mm) to two decimal places using digital callipers. The GL of Femurs, radii and tibiae are measured between the proximal and distal epiphyseal extremities, whereas measurements of humeri are taken between the distal termination of the trochlea and the proximal lateral tuberosity; ulnae measurements are taken between the tip of the olecranon process to the distal epiphyseal termination.
2. Using the formula listed in Table 6, shoulder height is calculated for each element as outlined by Harcourt (1976).

Table 6: Formula for calculating shoulder height of dogs from long bone measurements (after Harcourt 1974)

Shoulder height from long bone	
Long bone	**Factor**
Humerus	(3.43 x GL) - 26.54
Radius	(3.18 x GL) + 26.54
Ulna	(2.78 x GL) + 6.21
Humerus + radius	(1.65 x GL) - 4.32
Femur	(3.14 x GL) - 12.96
Tibia	(2.92 x GL) + 9.41
Femur + tibia	(1.52 x GL) - 2.47

4.2.3.2 Protocol for determining shoulder height from long bone measurements

1. To calculate SH, the greatest length (GL) of all complete metacarpals II-V and metatarsals II-V are measured using digital callipers and recorded in mm to two decimal places. For individual dogs represented by more than one metapodia, only one element is measured as all formulae demonstrate an almost equally high correlation coefficient.
2. Using the measurements of GL, SH is determined for each element using the formulae outlined in
3. Table 7.

Table 7: Formulae for calculating shoulder height of dogs from metapodia length (after Clark 1995**)**

Shoulder height from metapodia	
Element	**Factor**
Metacarpal II	(0.94 x GL) - 1.56
Metacarpal III	(0.83 x GL) - 2.03
Metacarpal IV	(0.84 x GL) - 2.60
Metacarpal V	(0.98 x GL) - 1.56
Metatarsal II	(0.86 x GL) - 2.04
Metatarsal III	(0.77 x GL) - 2.26
Metatarsal IV	(0.75 x GL) - 2.68
Metatarsal V	(0.83 x GL) - 1.75

4.2.3.3 Protocol for determining shoulder height from cranial dimensions

1. Cranial dimensions are taken between the *basion* and *ethmoideum* (Figure 11). The *ethmoideum* is medially the most rostral point of the *crista galli*, whereas the *basion* is the midpoint on the anterior margin of the *foramen magnum* (Janeczek 2014)
2. The following formula is employed to calculate SH. Whereas 'D' is the internal dimension of the crania measured from *basion* to *ethmoideum* as outlined in the study by Wyrost and Kucharczyk (1967):

$$SH = 1.016 \times D - 31.2$$

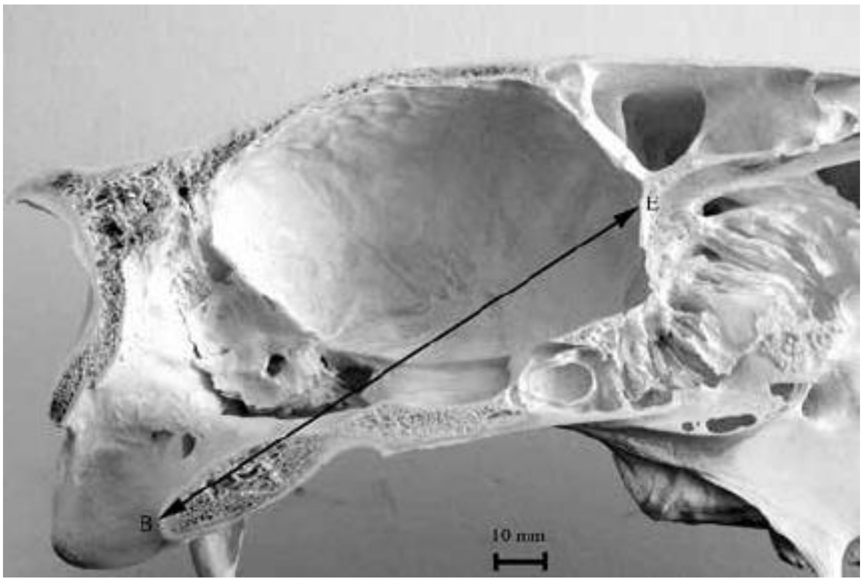


Figure 11: Cross-section of a horse skull demonstrating equivalent locations and the measurement between the ethmoideum (E) and basion (B) (Janeczek 2014)

4.2.4 Body mass

Another indication of morphological appearance of animals is elucidated via the calculation of body mass (BM). The osteometric measurements of long bones provide the most accurate estimations of body mass in carnivores, which can be calculated by measuring the circumferences of humeri and femurs (Anyonge 1993; Egi 2001; Legendre and Roth 1988; Onar *et al.* 2015). This is due to the relationship between the cross-sectional shape of long bones and the force applied to bone relative to the body mass of an animal (Alexander *et al.* 1979). A study by Anyonge (1993) developed a regression formula based on proximal long bone circumferences, i.e. femurs and humeri, in 28 species of extant carnivores, allowing estimations of body mass within a 30% error margin. Although significant, this margin of error is much lower than what is demonstrated in BM estimations based on cranial and dental measurements (Van Valkenburgh 1990).

4.2.4.1 Protocol for determining body mass

1. To measure the circumference of femurs and humeri a string is wrapped around the shaft of the diaphysis. The length is then measured from where two points of the string meet using digital callipers, recorded in millimetres to two decimal places. The circumference of a femur is taken at the midpoint of the shaft, halfway between both proximal and distal ends. The circumference of a humerus is recorded at 35% of shaft from the distal end.
2. To measure the BM from femur circumference the following formula by Anyong (1993) is employed, whereas '*f*' is the midpoint circumference:

$$BM = 10\ (2.88 \times \log (f)) - 3.4$$

3. To measure the BM from humerus circumference the following formula by Anyong (1993) is utilised, whereas ‘*h*’ is the circumference of the humerus.

$$BM = 10\ (2.74 \times \log (\mathrm{h})) - 2.72$$

4.2.6 Determining sex

Indications of the sex of an animal can aid in interpretations of mortality profiles, particularly when investigating the potentialities of carnivorous husbandry models (McCaughey 1966). Determining sex from skeletal remains is achievable in many canid species due to specific osteomorphological sexual dimorphisms observable between male and female individuals (Higham *et al.* 1980). However, morphometrically determining sex from domestic dog skeletal remains is problematic, largely due to the prolonged history of human selection having led to insurmountable variances in size between different individuals both intra- and interbreed (Clutton-Brock 1995). The presence or absence of a defined saggital crest on a cranium can occasionally be an indication of male or female sex respectively, although this is not a consistent marker (Shigehara *et al.* 1997; Worthington 2008, 13). Concrete sex determinations are only possible with the presence of the one distinguishable bone that is associated with the male sex organ, the *baculum*. There is some indication that the morphological traits of complete humeri can determine sex to a certainty of 85% (Ruscillo 2002, 62). However, this method is reliant on the presence of complete humeri, whether the humerus falls when placed on a flat surface in a particular way and is subject to the high degree of improbability. For these reasons, and due to the qualities of the sample collection in which complete humeri are largely absent, the determination of sex is largely unfeasible for the vast majority of material investigated in this study.

4.2.7 Investigation of bone surface modification

An assessment of intentional manipulation of bone, whether it be from butchery or cooking, is important in ascertaining the treatment of individual dogs recovered from the sites of El Flaco and El Carril. There are several observable traits in faunal remains that can indicate the intentional anthropogenic manipulation of elements. These include cut marks, human tooth marks, fracture patterns, and thermal transformation resulting from cooking (Botella *et al.* 2000; Denys 2002; Landt 2007; Pearce and Luff 1994; Shipman *et al.* 1984; White 1992). Outlined below are some of the techniques of observation that are employed in this study, including the justificatory reasoning behind the investigation of such phenomena. The motivating principle in the study of bone surface modifications is to investigate the possibility of dog remains from El Carril and El Flaco having undergone intentional manipulation by human action.

4.2.7.1 Butchery

The most common forms of anthropogenic manipulation of bone observable macroscopically are that of cut marks and fracture patterns. The analysis of cut-marks in this study followed methods outlined for larger mammals by Binford (1981), Potts and Shipman (1981), Blumenschine *et al.* (1996) and Dominguez-Rodrigo *et al.* (2009). In terms of cut mark morphology there are three discernible actions that can be observed at low magnification, that of scraping, chopping, and slicing. Chop marks are caused by the striking of a bone surface with a tool at a perpendicular angle, creating cross-sections that are characteristically V-shaped and exhibit bone particles that are crushed inwards towards the bottom of the deepest groove (Figure 12). Scraping marks are caused by the perpendicular dragging of an artefact edge along the longitudinal axis of a bone, creating multiple fine striations in parallel directions across a much wider surface area than what is seen in slicing (Figure 13). These markings are often broader than slice marks, which are demonstrably finer and possess more parallel striations (Figure 14) (Potts and Shipman 1981).

The placement of cut marks is telling of the butchery practices employed. Cut marks associated with skinning activity for larger mammals such as bovids, cervids and suiformes are usually observed around the lower legs and the cranium, and often encircle the surface of the bone (Binford 1981, 107). However, in smaller animals, cut marks around metapodia have also been interpreted as the being the result of skinning activity (Lebreton *et al.* 2017).

Dismemberment marks are some of the more distinguishable markings that can be attributable to human action and are usually associated with epiphyseal articulation areas. Cut marks on long bones usually follow the pattern of being associated with articulation centres; femurs can demonstrate markings near the distal epiphysis, whereas tibiae and humeri can exhibit markings on both proximal and distal epiphyses on the anterior and posterior sides (Binford 1981; Lyman 1987a). Filleting cuts are a secondary butchery action and are largely oriented on the longitudinal axis of the bone, or occasionally take the form of shorter cuts made to the underside of the bone to sever muscle attachments and remove meat from the bone. These markings take place at a further distance from the epiphyseal articulation points (Binford 1981).

Cut marks are distinguishable from trampling by their less-random orientation, directional straightness, perpendicular or oblique orientation against the axis of the bone, non-overlapping subsidiary striations, and the formation of flaking on shoulder margins of the main groove (Domínguez-Rodrigo *et al.* 2009). The number of cut marks present also allows disseminations between natural and cultural processes, with trampling affecting the appearance of more markings compared to that of intentional butchery practices (Olsen and Shipman 1988).

Analysis of fracture patterns are another avenue of investigation when attempting to determine human action in the manipulation of bone surfaces (Davis 1987). The presence of percussion notches on bone

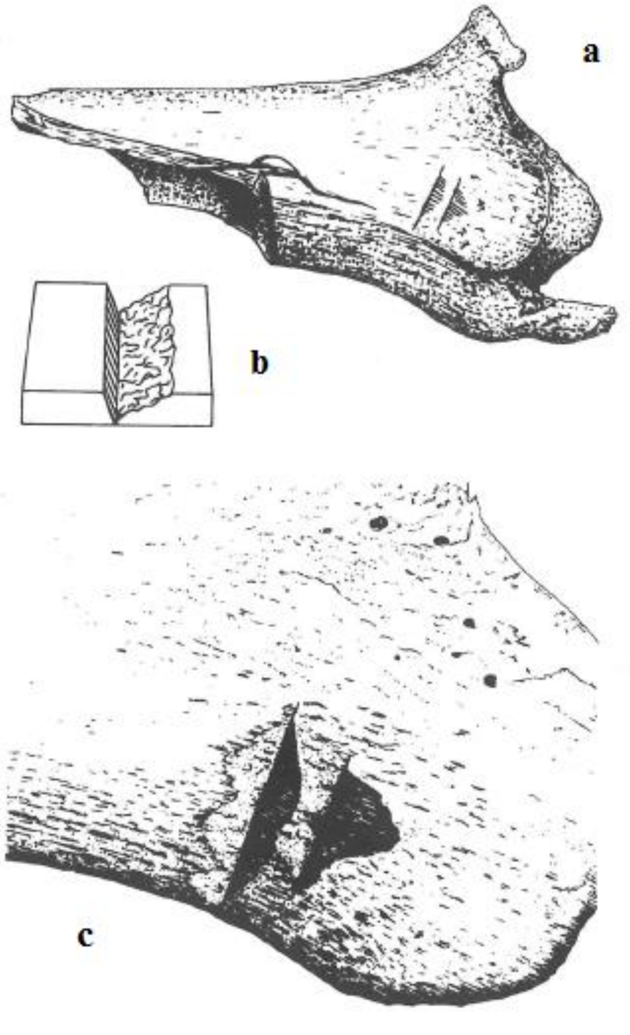


Figure 12: Chop marks on a red deer (*Cervus elaphus*) tibia. (a) Distal tibia fragment; (b) Cross-section of chop mark; (c) Detailed drawing of chop mark. (Noe-Nygaard 1989)

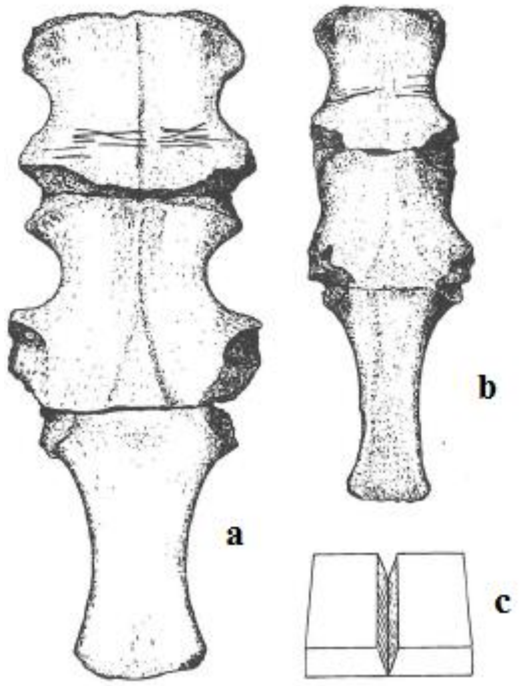


Figure 14: (a, b) Slice marks on a *Cervus elaphus* sternum; (c) Cross-section of slice marks showing narrower V-shape compared to chop marks (Noe-Nygaard 1989)

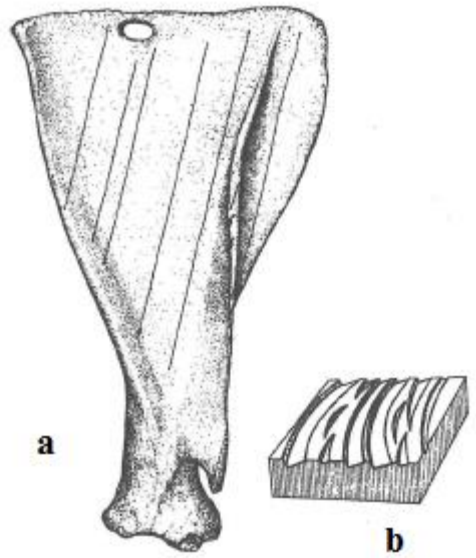


Figure 13: (a) Scrape marks on a *Cervus elaphus* scapula; (b) cross-section of scrape marks (Noe-Nygaard 1989)

surfaces are the only truly reliable criteria for determining human caused fragmentation of animal remains for the extraction of marrow (Capaldo and Blumenschine 1994). Interpretations of fracturing can only be subjectively ascertained and are dependent on the depositional context of the remains studied. However, certain fracture patterns have been interpreted as the best evidence of human activity, particularly spiral fractures which may be caused by intentional mid-shaft breaks for the purposes of marrow extraction (Bonnichsen 1979, 69; Lyman 1987).

4.2.7.2 Limitations in butchery analysis

As a caveat, the techniques of analysis outlined for this research are based on studies of markings made by either lithic or metal tools, whereas the common use of shell tools has been noted for the precolonial Greater Antilles (Keegan and Carlson 2008, 123; O'Day and Keegan 2001). A microscopic investigation into differences in butchery markings made by Antillean non-lithic tools on small to medium-sized fauna would be beneficial for future studies, particularly in aiding to distinguish possible shell-made markings that may be presently conflated with scavenger gnawing activity.

Taphonomic concerns also affect the appearance of bones, and often making distinctions between human action and post-depositional processes problematic. Skeletal preservation is affected by a myriad of environmental conditions that transform the post-mortem remains of an animal. Exposure to the elements can lead to disintegration of bone minerals via the effects of precipitation, humidity, temperature and Aeolian processes. Additionally, post-burial, or diagenetic (Nicholson 2001) effects such as plant root action, humic acids, fungus and the presence of algae in soil can lead to the weathering of bone (Millard 2001). Diagenetic effects are both macro- and microscopically observable and include chemical deterioration of organic material (hydrolysis); chemical deterioration of inorganic material (dissolution); and microbial action (Child 1995; Collins et al. 2002; Hedges 2002; Kontopoulos et al. 2016).

Additionally, discerning fracturing resultant from trampling is also an issue, although trampling often results in simple fracture patterns usually in the mid-shaft region of bone (David 1987, 26). In general, bone breakage patterns should only be comparatively analysed as patterns according to archaeological context and between bones that are of similar structure, as different elements undergo disparate taphonomic processes (Gifford 1981; Lyman 1987a; Shipman *et al.* 1984)

Butchery analysis techniques have recently been criticised for their lack of empirical strength. This is due to the high potential for subjective interpretations regarding identifying the location and causative function of anthropogenic marks. Blind experiments on various researchers from the same institution have determined a large variance in what cut marks were observed and where they were located, even by researchers from the same educational training (Domínguez-Rodrigo *et al.* 2017). Additionally, there is a lack of experimental testability of certain factors such as the effects of fossilization in the production of marks that could be misconstrued as being anthropogenic (James and Thompson 2015). With this in mind, any observations made in this research should not be seen as direct evidence of butchery having definitively occurred.

4.2.7.3 Gnawing

Another factor that may influence both the depositional context of certain elements and visible bone surface modification is the action of scavengers. Due to the peculiar biogeography of the Greater Antilles there is an absence of small to medium-sized mammals that would partake in a scavenging subsistence. Carrion birds inhabit Hispaniola, notably including the turkey vulture (*Cathartes aura*) (Latta *et al.* 2006, 57), which could account for possible dissemination of unburied remains, however these are unlikely to account for depositions of faunal material within archaeological contexts. The likely candidate for nonhuman manipulation on faunal material is action by dogs. Domestic dogs have been shown to be a significant taphonomic factor affecting elemental survival and bone surface modification at numerous archaeological sites around the world (Kent 1993). Controlled experiments conducted by Kent (1981) determined that the presence of observable dog gnaw marks is variably associated with how an element has been cooked, bone size and density, and the frequency in which dogs have access to bones for consumption.

According to Binford (1981, 44-48), there are four morphological characteristics of tooth marks on bone: pits, punctures, scores and furrows. Punctures occur when bone surface has been subjected to force from a tooth, collapsing in the process. These are characterised by clear imprints of that can affect the appearance of holes in thinner, cancellous bone. Pitting occurs when bone material is strong enough to withstand collapsing under the pressure of bite force, leaving a shallower imprint than puncture marks. Scoring occurs with the scraping of teeth against the surface of a bone and are often linear in nature, occasionally being mistaken for cut marks. Furrowing (Haynes 1960 in Binford 1981) occurs with the scooping out of bone apatite as part of gnawing action, often leading to undulating cross-sections as teeth movement responds to condensed and harder aspects of a bone. The determination of gnawing action is important in piecing together the taphonomic processes that have affected the depositional context and preservation of the dog remains in this study. An analysis of gnawing illuminates post-mortem manipulations of dog remains by scavengers or by other members of the same species.

4.2.7.4 Cooking

The determination of heat treatment of bones is problematic in the absence of direct evidence of burning. Notable characteristics that have been used to determine heat treatment are changes in colour, microscopic morphology, crystalline structure and shrinkage. The most obvious signs of heat treatment are the result of exposure to high temperatures which lead to differences in coloration ranging from the blackening of edges, to partially incinerated bone that is dark brown or blackened, to completely incinerated bone that can be grey or bluish-white in colour (Shipman *et al.* 1984; Stewart 1979). Macro-observable traits of low temperature treatment include smoothness and the relative transparency of a bone (Botella *et al.* 2000; Pijoan *et al.* 2007). At a microscopic level the act of cooking has a demonstrable effect on the micromorphology, chemical composition, texture and structure of bone structure according to the temperature of exposure. These results can be determined by scanning electron microscopy (SEM), transmission electron microscopy (TEM), small-angle X-ray scattering (SAXS), XRD and gas adsorption (Pijoan *et al.* 2007; Solari *et al.* 2013).

Solari *et al*. (2013) noted a multitude of factors can account for post-depositional taphonomic diagenesis of bones. It is possible that these effects can either negate evidence of burning, or in turn mimic the effects of low heat treatment on bones. Also, cooking methods may affect the depositional survival of indiscriminate faunal elements (Kalsbeek and Richter 2006). This is particularly evident when remains are exposed to scavengers, as roasted carcasses exhibit less original skeletal elements compared to boiled carcasses, possibly due to the comparatively weaker level of muscular and ligament articulation in roasted animals (Ugan 2010).

An analysis of possible cooking processes using archaeometric techniques will not be undertaken. This decision is made due to a lack of logistical capabilities for employing such techniques. Besides from the problematic and highly subjective nature of determining the method of heat treatment macroscopically, an assessment of the relative survival or completeness of the specimens investigated in this study is unfeasible. This is due the limited sample size and the depositional predilection for isolated individual elements that were recovered during excavation.

4.2.7.5 Protocol for recording and analysing bone surface modification

1. A visual analysis of possible cut marks, fracture patterns and observations of possible heat treatment was undertaken on all faunal material. Fracture patterns were observed, although given the lack of viability for determining the causes of all fractures in this assemblage special attention will be given to spiral fractures that have a higher likelihood of being anthropogenic (Binford 1981; Bonnichsen 1979; Lyman 1987a). Heat treatment was only recorded if there were obvious signs of direct burning such as whitening, greying or blackening of elements. Elements that were suspected of exhibiting human-caused

markings, either of percussion for marrow extraction or cut marks for de-fleshing, skinning or disarticulation were photographed, drawn and analysed according to the criteria outlined by Potts and Shipman (1981) and Binford (1981).

2. Macroscopic recording of butchery marks involved the recording of:
    a. the placement of potential cut marks on individual elements;
    b. the linear direction of grooves;
    c. the perpendicular or oblique orientation of marks compared to the axis of the bone and;
    d. the number of markings present.
3. Microscopic enhancement and photography aided in determining the cause of bone surface modifications, employing a Leica M80 Modular Routine Stereo Microscope with 8:1 Zoom in the Material Culture Studies Laboratory at Leiden University. The use of low-level microscopic enhancement aided in the visualisation of internal and external striations of groove marks.

4.3 Outline of isotope ratio analysis

The second portion of this study employed stable isotope ratio (SIR) analysis on canine samples from El Flaco and El Carril in the Dominican Republic, and samples obtained from Sandrine Grouard from Morel in Guadeloupe and Hope Estate in St Martin. Multi-isotopic analysis enabled more holistic determinations of dietary regimes and animal mobility, beyond what can be observed via other modes of archaeological inquiry. The results from the analysis of carbon ($\delta^{13}C_{co}$) and nitrogen ($\delta^{15}N$) ratios obtained from samples of bone collagen, and carbon ($\delta^{13}C_{en}$) and strontium ($^{87}Sr/^{86}Sr$) from dental enamel were compared with isotopic findings of humans and dogs from El Flaco and El Cabo in the and other sites in the Dominican Republic and Morel in Guadeloupe (Hofman *et al. in prep*; Laffoon 2017; *et al.* 2017) and data published by other researchers (see Pestle 2010; Stoke 1998). Collagen samples from Hope Estate, Cathédrale de Basse-Terre, and Morel, processed as part of this study, serve for comparisons. The aim of employing SIR analyses was to determine the dietary regimes of these animals, and to assess whether there are notable differences in diet that can aid in distinguishing differential treatment of certain individual dogs, according to what they were fed by or scavenged from humans.

Stable isotopes differ according to the number of neutrons present within an atom which affect the relative atomic mass, these differences in atomic mass lend to miniscule differences in the reactive properties of elements. Rarer, high-mass isotopes are most prominently observed within stable systems such as within liquids or solids rather than gases. Biochemical or kinetic processes lead to the entropic decay of isotopes, known as fractionation, the study of the effects of these processes allows a tracking of particular elements through different bio-physical pathways (Lee-Thorp 2008; Sharp 2007).

This component of the study involved the extraction of tooth enamel to assess the SIR levels of carbon ($\delta^{13}C_{en}$) to determine the dietary causes of relative carbon enrichment. The same enamel samples underwent strontium ($^{87}Sr/^{86}Sr$) ratio analysis to assess whether the tested individuals were raised locally or non-locally according to the geochemical signature exhibited in adult teeth (Bentley 2006). A by-product of carbon analysis via mass spectrometry is data pertaining to oxygen ($\delta^{18}O$) isotope ratio values, the analysis of which has shown some limited applicability in determining palaeoclimatic conditions and provenance, due to its correlative association with surrounding environmental hydrology (Colonese *et al.* 2007). To further assess the palaeodiet of these animals, collagen was extracted from select elements of individual animals to assess carbon ($\delta^{13}C_{co}$) and nitrogen ($\delta^{15}N$) isotope values. Nitrogen ratio analysis can indicate the trophic level of an organisim, as there is a correlative link between increased $\delta^{15}N$ levels and higher trophic levels within a food web (DeNiro and Epstein 1980).

SIR palaeodietary reconstruction is particularly useful for determining human-caused dietary regimes in regions that exhibit an abundance of C_4 plant domesticates or marine resources (Laffoon 2017 *pers comm.;* Lee-Thorp 2008; Schoeninger *et al.* 1983; Sharpe *et al.* 2018; Sugiyama *et al.* 2015). Given that pre-colonial cultures in the insular Caribbean are known archaeologically and historically to have consumed C_4 plant domesticates, particularly maize, and were variably reliant on marine resources, the sites covered in this study are highly applicable for reconstructing a dietary relationship between human diet and that of animals (Krigbaum *et al.* 2013; Laffoon *et al.* 2016a; Pestle 2010; 2013). Studies have demonstrated that different species of animals vary in their conversion rates of bioavailable carbon and nitrogen, however the sharing of foodways can be adequately investigated if human and animal isotopic signatures share definitive similarities (Hopkins and Ferguson 2012). For this reason, and beyond what has been observed in other animals, dogs have been shown to be used as a palaeodietary proxy, or isotopic surrogate for the reconstruction of human diets in the absence of adequate human samples (Guiry 2012).

More on these techniques are mentioned below, followed by a summary of the application of SIR analysis in the Caribbean and the protocol for conducting SIR analyses using the *Canis lupus familiaris* sample material outlined in Chapter Five: Sites and Materials.

4.3.1 Overview of Carbon ($\delta^{13}C$) ratio analysis from bone collagen, apatite and tooth enamel

The analysis of carbon isotope ratios from bone collagen, apatite and dental enamel is the most widespread technique for isotopically investigating diet. The consumption of ^{13}C enriched foods is reflected within the stable isotope ratio values of an organism's remains, so it is useful for indicating the general types of food that are consumed by an individual (Lee-Thorp *et al.* 1989). Within ecological systems the most prominent source of variability with carbon isotopes is present within primary producers, namely plants. The analysis of carbon ratios ($\delta^{13}C$) from tooth enamel and bone collagen and apatite is therefore indicative of an organism's intake of carbon isotopes, either through direct consumption of certain plants, or indirectly via the consumption of other animals (Schwarcz and Schoneninger 1991).

What determines the level of carbon isotopic enrichment within dietary sources is dictated by the functioning of metabolic pathways of plant types that form the lowest component of a food chain. These plants are commonly designated as C_3, C_4 or Crassulacean Acid Metabolism (CAM) plants, each of which are adapted to different environment niches, which is in turn reflected within their adaptive photosynthetic processes (Ehleringer and Cooper 1988; Fahquhar *et al.* 1980; Lee-Thorp 2008; Lee-Thorp *et al.* 1989; Vogel and van der Merwe 1977). The most common variety, C_3 plants, are best conditioned to non-tropical climates with moderate levels of sunlight intensity and temperature. Plants of this variety undergo higher levels of ^{13}C depletion (-37 to -20‰) when compared to C_4 plant types (-16 to -9‰) (Kohn 2010; O'Leary 1988; Raven and Edwards 2001; Vogel 1993, 29). Harsher environmental considerations have led to plants with C_4 metabolic systems that are more advantageous in environments that demonstrate high temperatures, water scarcity and atmospheric deficiencies of CO_2 or nitrogen gases. Due to these adaptive qualities, C_4 plants are more suited to tropical, subtropical and arid environments, although they are rare, accounting for approximately 3% of known plant species (Bond *et. al* 2005). CAM plants are also adapted to have increased water retention capabilities and are therefore suited to arid environments. These plants tend to demonstrate overlapping isotopic ratios (-33 to -12‰) with some C_3 plants and the majority of C_4 plant types, although their rarity within agricultural contexts means they likely do not contribute immensely to the whole diets of human populations (Bianchi *et al.* 1993; Kohn 2010; O'Leary 1988; Vogel and van der Merwe 1977). Agriculturally important C_3 plants include all known tree species, grains such as barley, oats, rice and wheat, and root crops such as potato, yam and manioc. Some important C_4 crops are sorghum, millet, cane sugar and maize (Lee-Thorp 2008). Within the insular Caribbean, archaeologically known important indigenous plant domesticates include C_4 maize and C_3 manioc, maranguey and cocoyam (Pagán-Jiménez and Carlson 2013).

Another dietary parameter that can lead to differences in carbon values is the consumption of aquatic plants or animals (Schwarcz and Schoneninger 1991; Smith and Epstein 1971). The relatively high carbon enrichment present in marine plants means that the analysis of carbon ($\delta^{13}C_{co}$) values in bone collagen can be used in ascertaining the contributions of marine versus terrestrial protein sources (Chisholm *et al.* 1982; Schoeninger *et al.* 1983; Tauber 1981). However, clearly determining the composition of diets can be problematic in areas that demonstrate a varied diet reliant on both marine and terrestrial resources (Lee-Thorp *et al.* 1989). For this reason, assumptions relating to dietary composition can only be reasonably deduced when the biogeography of a region is well-known, and when palaeobotanical and archaeofaunal evidence can educate to dietary practices.

The analysis of different skeletal elements such as dental enamel, dentine, bone collagen and apatite can indicate differences in carbon intake due to varied patterns of incremental growth and differential routing of macronutrients (Fernandez *et al.* 2012). Controlled feeding experiments (see Ambrose et al. 1997; Froehle et al. 2010; Hare et al. 1991; Newsome et al. 2011; Schwarcz 2001) have indicated that bone collagen ratios differ from bone apatite and dental enamel in that only one quarter of carbon values are derived from carbohydrates and lipids, the rest (~75%) is indicative of protein intake. For this reason, bone collagen serves as a better indicator of relative protein intake, whereas hydroxyapatite (enamel and bone apatite) reveal the averaged whole diet (Ambrose and Norr 1993; Fernandez *et al.* 2012; Froehle *et al.* 2010). Bone and enamel also differ in that isotopes values within bone collagen and apatite are more reflective of long-term averages, depending on the age of the individual and variances in biochemical turnover rates associated with bone types (Hedges *et al.* 2007; Lee-Thorp 2008). Enamel however is formed largely during the juvenile stages of development and remains biochemically fixed. Adult tooth enamel is an indication of the dietary component of an individual when they reached dental maturity (Hillson 1997), it is also less subject to diagenetic processes that effect the preservation of other tissues (Lee-Thorp 2008). Collagen is more susceptible to diagenesis, and in tropical environments is often diminished beyond utility after around 10,000 years (Hare 1980; Pestle and Colvard 2012). Due to these differences in macro-nutritional routing and biochemical fixation, an examination of both dental enamel and bone collagen from different individuals will be undertaken in this study, with a methodological preference for elements (mandibles or maxillae containing teeth) that can be concurrently sampled for both materials.

Carbon isotope ratios are expressed in delta notation (δ) in parts per thousand (‰) as a ratio of the amount of heavier ^{13}C against lighter ^{12}C isotopes present within a sample (Fernandez *et al.* 2012). For empirical consistency, these results are calculated against a globally agreed reference standard of carbonate obtained from a fossilised *Belemnitella americana* excavated from the Peedee formation of South Carolina (PDB) (Craig 1953; Smith and Epstein 1971). As outlined by Fernandez *et al.* (2012), the expression of carbon isotope ratios follows this formula:

$$\delta^{13}C = (^{13}C/^{12}C_{sample} - {}^{13}C/^{12}C_{standard}) / (^{13}C/^{12}C_{standard}) \text{ x } 1000‰$$

4.3.2 Overview of Nitrogen ($\delta^{15}N$) isotope ratios obtained from bone collagen

Another line of investigation that can relatively establish the potential origins of sources of protein within an organism is the analysis of nitrogen isotope values obtained from bone collagen. Nitrogen

($\delta^{15}N$) ratios within bone collagen are similar to that of carbon, in that the $^{15}N/^{14}N$ ratios expressed within an organism are directly related to the $^{15}N/^{14}N$ ratios of plant groups that form the lowest trophic level within a food chain. $\delta^{15}N$ values are a useful assessor of the consumption of taxa from either terrestrial or marine environments due to that marine plants generally exhibit higher $^{15}N/^{14}N$ ratio values than terrestrial plants (Sweeney *et al.* 1978).

The enrichment of heavier nitrogen isotopes has been shown to increase with each higher trophic level (DeNiro and Epstein 1980; Steele and Daniel 1978). Experimental feeding studies by DeNiro and Epstein (1980) were conducted on several animals (n=13) including brine shrimp, nematodes, blow flies, moths, snails, grasshoppers, weevils, milkweed bugs and mice. Their results demonstrated that $\delta^{15}N$ levels were enriched by each animal compared to the specific dietary that they were subject to, with Δ animal-diet enrichments ranging between +3.0 ± 2.6‰ across the sample group. These results also indicated that when the $\delta^{15}N$ ratios of a food source is known it is possible to distinguish this within the $\delta^{15}N$ values of the consumer's bone collagen. Levels of nitrogen enrichment increase according to the subsistence practices of organisms, with plants demonstrating the lowest levels and carnivores exhibiting the highest levels. Since marine ecosystems possess more trophic levels than terrestrial ecosystems nitrogen values tend to be far higher in peak marine predators (DeNiro and Epstein 1978; Minagawa and Wada 1984).

Schoeninger *et al.* (1983) tested the isotopic compositions of bone collagen from several historic human populations; Alaskan Eskimos, and Haida and Tlingit Indians from the coastal north-western United States; inland manioc farmers from Colombia, and Havihuh from New Mexico; and prehistoric populations from the Bahamas. All these populations demonstrated clearly differentiated results according to their either terrestrial or marine subsistence patterns. However, the results from Bahamians were considerably lower (mean of +11‰) than other groups that practiced intensive fishing and harvesting of marine resources (Schoeninger and DeNiro 1983). This was explained by the large amount of nitrogen fixation that is exhibited by plants that inhabit coral reefs, mangrove swamps, seagrass meadows and salt marshes (Capone and Carpenter 1982; Keegan and DeNiro 1988). Marine organisms within food chains in which plants demonstrate a high amount of nitrogen fixation will demonstrate lower $\delta^{15}N$ values (Wada and Hattori 1976).

As outlined by DeNiro and Epstein (1980), nitrogen values are expressed in delta notation (δ) in parts per thousand (‰). The ratio is dictated by heavier (^{15}N) to lighter (^{14}N) isotopes. The standard for measurement against is atmospheric nitrogen (AIR). The expression of nitrogen isotopes follows this formula:

$$\delta^{15}N = [(\delta^{15}N/\ \delta^{14}N)_{\text{sample}} / (\delta^{15}N/\ \delta^{14}N)_{\text{standard}} - 1] \times 1000‰$$

4.3.3 Overview of strontium ($^{87}Sr/^{86}Sr$) isotope ratios obtained from dental enamel

Strontium isotope analysis is the most widely exploited isotopic technique in archaeology for establishing evidence of human and animal mobility (Bentley 2006). Unlike carbon, and particularly nitrogen, strontium does not experience significant isotopic fractionation in association with trophic level (Price *et al.* 2002). For this reason, the examination of strontium isotopes can give a geographical indication of where an organism sourced most of its nutrients during its development.

The underlying principle behind the examination of strontium ($^{87}Sr/^{86}Sr$) ratios is that biogenic tissues such as bone and teeth are in isotopic equilibrium with the local biochemical signatures of environments. The main source of strontium in terrestrial ecosystems stems from the chemical and physical weathering of minerals from bedrock, which in turn is absorbed by plants, subsequently permeating all branches of a local food web (Bentley 2006; Laffoon *et al.* 2017). Strontium finds its way into skeletal tissue as it is readily substitutable for calcium during processes of bone genesis, due to its ionic radius (1.32 A^o) being only incrementally larger than that of the latter element (1.18 A^o). Of all biogenic material, dental enamel is the most applicable for strontium analysis due to its high resistance to diagenesis (Budd *et al.* 2000) and unlike bone, enamel does not undergo remodelling throughout the life of an individual (Laffoon *et al.* 2017). As adult tooth enamel is biogenically fixed after eruption, the analysis of $^{87}Sr/^{86}Sr$ ratios of tooth enamel can indicate mobility should the isotopic ratios of a specimen differ from the bioavailable strontium within the immediate region.

The geological sources and elemental characteristics of strontium enable deductions as to the original provenance of an organism. There are four naturally occurring strontium isotopes, three of them are non-radiogenic (^{84}Sr, ^{85}Sr, ^{86}Sr), whereas ^{87}Sr is formed due to the decay of rubidium (^{87}Rb) which has a half-life of 4.88 x 10^{10} years (Bentley 2006). $^{87}Sr/^{86}Sr$ ratios tend to vary substantially between geological terrains, both due to differing degrees of original Rb/Sr composition when formed, and the age of the bedrock and which affects the amount of rubidium that has radioactively decayed, forming the ^{87}Sr isotope. Bedrock possessing a high original composition of Rb/Sr that is older than 100mya generally indicate ratios above 0.710. More recently formed bedrock with low Rb/Sr ratios tend to possess $^{87}Sr/^{86}Sr$ below 0.704 (Bentley 2006). Relevant to the insular Caribbean region, oceanic island arcs formed by subduction processes tend to range between 0.7035 - 0.707 (Dickin 1995, 164-169), marine limestone and dolomite deposits exhibit intermediate ranges of around 0.707-0.709, whereas continental crusts vary between 0.702-0.750. Strontium provenance studies are only applicable for terrestrial organisms as $^{87}Sr/^{86}Sr$ of oceanic water represents the average global composition of weathered continental crust (Bentley 2006).

4.3.4 Isotope studies in the Caribbean

Due to the varied geologies and clear spatial patterning of bioavailable $^{87}Sr/^{86}Sr$ signatures in the insular Caribbean, the application of strontium ratio analysis is particularly useful for examining the mobility of humans and animals in this region. To coalesce the variation within the insular Caribbean, large-scale empirical datasets have been formulated, and spatially specific models have been developed to estimate the likely levels of bioavailable strontium isotopes, commonly known as 'isoscapes' (Bataille *et al.* 2012; Laffoon *et al.* 2012). Studies have been conducted that demonstrate the mobility of humans and animals both inter-island and from the mainland into the insular Caribbean (Laffoon *et al.* 2015; 2016; 2017), as well as demonstrating widespread trade networks as evidenced in the distribution of mainland South American animal tooth pendants in Puerto Rico (Laffoon *et al.* 2014).

The isotopic assessment of indigenous palaeodiets has aided a more holistic reconstruction of the varied dietary practices throughout the pre-colonial Caribbean. Extensive SIR palaeodietary studies on human remains have indicated that there are varying degrees of regional divergence and overlap in the dietary intake of humans throughout the Greater and Lesser Antilles (see Chinique de Armas *et al.* 2015; 2016; Keegan and DeNiro 1988; Krigbaum *et al.* 2013; Laffoon 2016; Laffoon *et al.* 2016a; 2017; Pestle 2010; 2013). A large regional overview of human palaeodiets was undertaken by Anne Stokes (1998), who assessed carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) values from 102 pre-colonial individuals obtained from 18 archaeological sites on 13 different islands. This study covered the beginning of the Ceramic age (Saladoid c. 400 BC to AD 600) to the post-Saladoid (AD 600 to 1500) and the beginning of European colonisation. Stokes' results demonstrate little temporal variation, suggesting continuous pre-colonial culinary trends that changed little over a period of a thousand years. However, the assumption of temporal homogeneity concerning diet is constantly being reassessed with the accumulation of larger datasets. Laffoon *et al.* (2016) demonstrates that results from Stoke's (1998) analysis of two early Ceramic age individuals from Pearls, Grenada are on average similar to post-Saladoid individuals from Lavoutte, St Lucia, although differing greatly in apatite values ($\delta^{13}C_{ap}$). This difference is perhaps indicative that there may have been an increasing reliance on C_4 plants such as maize in later periods.

With ever expanding datasets, regional and temporal variations are becoming more nuanced. Comparable to other regions, biogeographical variables in the Caribbean can often lead to unique isotope signatures that differ intra-regionally. This degree of variation is more apparent in the assessment of bone collagen values, which are largely indicative of protein intake, suggesting that there were explicit differences in subsistence strategies between values obtained from the smaller islands of the Lesser Antilles compared to that of the Greater Antilles. This has been interpreted as an indication of a more widespread reliance on terrestrial resources related to island size in the Greater

Antilles (Laffoon *et al.* 2017; Pestle 2010; Stokes 1998). However, although there is definitively less overlap in collagen values, the assessment of carbon ratios from bone apatite and enamel indicate that there is significantly more regional overlap in carbohydrate intake (Ambrose and Norr 1993; Laffoon *et al.* 2017). These regional variations, particularly in protein intake, are suggestive that there was a variety of subsistence practices throughout the Caribbean, although perhaps with a reliance of domestic crops such as maize or manioc, as is indicated palaeobotanically (Newsom and Wing 2004).

The Caribbean region is well suited for the assessment of provenance via strontium isotope analysis due to the diversity of geological signatures evident throughout the islands (Donovan and Jackson 1994). The establishment of baseline isoscapes have allowed analyses of human and animal palaeomobility, and the provenance of artefacts made from animal products from a number of sites; such as Anse à la Gourde, Guadeloupe (Booden *et al.* 2008; Hoogland *et al.* 2010; Laffoon and de Vos 2011; Laffoon *et al.* 2015); from the islands of Carriacou, Nevis and Mustique (Giovas *et al.* 2016); Lavoutte, St Lucia (Hofman *et al.* 2012); in Puerto Rico (Laffoon 2016; Laffoon *et al.* 2014); the Dominican Republic (Laffoon *et al.* 2017); Dos Mosquises island, Venezuela (Laffoon *et al.* 2016b); and El Chorro de Maíta in Cuba (Valcárcel Rojas *et al.* 2011). These studies have established that human mobility and networks of exchange were both nuanced and frequently occurring throughout the region prior to the arrival of Europeans (Hofman *et al.* 2014). Of relevance to this research are provenance studies that were conducted at Anse à la Gourde and Morel in the Guadeloupe (Laffoon *et al.* 2015) and at El Flaco and El Cabo in the Dominican Republic (Laffoon *et al.* 2017) that have served to demonstrate the interrelationship in the palaeomobility of dogs and humans. These studies suggest processes of exchange and or migration that effected both species and are reflective of high levels of entanglement on an individual level governing either the trade of dogs or the concurrent migration of dogs and humans throughout different regions in the Caribbean.

4.3.5 Canine surrogacy approach

Studies since the 1970s, have demonstrated a trend of similarities between the dietary composition of dogs and humans (see Burleigh and Brothwell 1978; Clutton-Brock and Noe-Nygaard 1990; Katzenberg 1989; Murray and Schoeninger 1988,164; Noe- Nygaard 1988). Burleigh and Brothwell's (1978) study pioneered this line of investigation in their stable carbon isotope study of Peruvian dogs, which suggested a diet comprised of maize, and provided deductive evidence of changing human agricultural practices in the region. This has led to the formulation of the 'canine surrogacy approach' (CSA), in which dog remains can theoretically be used to assess human diet, should human remains not be available for analysis. The substantial amount of human and dog collagen studies conducted since the 1970s and 1980s have indicated similarities of $\delta^{13}C$ and $\delta^{15}N$ levels ranging from 2-3‰ between tested individual humans and dogs (Guiry 2012). There are multiple reasons why such dietary similarities are commonly found, however the likely reasons are commensality or the scavenging of human refuse by dogs (West and France 2015).

There are however some notable differential trends between humans and dogs, explicitly in the observation of consistently lower comparative $\delta^{15}N$ values in dogs (Cannon *et al.* 1999; Hogue 2003). This difference is reflective of trophic level reduction compared to humans and could either be caused by the human consumption of dogs (Richards *et al.* 2009), differences in carbon and nitrogen fractionation associated with metabolic processes (Cannon *et al.* 1999), or possibly the canid behaviour of caceaotrophy (Allitt *et al.* 2008). Biological differences between the two species can also lead to isotopic variances, such as the shorter lifespan and the higher rate of bone remodelling ranging from six months to three years in dogs (Fischer *et al.* 2007). This higher turnover of biogenic material means that isotopic signatures in dogs are more reflective of short-term dietary intake compared to humans (Guiry 2012).

4.3.6 Lab protocols

Two different biogenic materials are analysed as part of this study; bone collagen and dental enamel. These two materials require different procedures of extraction, to eliminate pollutants such as unwanted organics and carbonates from the samples. After these processes have been completed, weighed samples are submitted for mass spectrometry at the Faculty of Science, Vrije University (VU) Amsterdam. The different processes of extraction for enamel and bone collagen are outlined below.

4.3.6.1 Enamel extraction protocol

1. A selection of samples is made ensuring that individuals are not repeatedly sampled, according to archaeological context and determined age. Preference is given to sampling the same elements (e.g. right upper canines) to ensure no repeated sampling. These samples are cleaned with water to remove any excess visible dirt.
2. The outer layer of teeth (enamel layer) is abraded off with a hand-held Proxxon Micromot System drill, with care taken not to include any loose particulates that may still be present after the cleaning process.
3. The drilled powder is then inserted in a pre-weighed test tube, after which the tube is weighed again to ascertain whether an adequate sample amount has been gathered (approximately 3-5mg).

The following chemical treatment protocol is slightly modified from the procedure outlined by Bocherens *et al.* (2011):

1. To eliminate organic pollutants:

   Add 1mL of 2-3% sodium hypochlorite (NaOCl) solution and leave samples in solution at room temperature for 20-24 hours. After adequate time has passed, centrifuge the samples and remove the NaOCl solution with a clean pipette. Rinse with 1 ml of de-ionised water, vortex, centrifuge and remove the water with a clean pipette, repeat this rinsing step 3-4 times in order to remove all residual bleach solution.
2. Elimination of labile carbonates:

   Introduce 1 mL of 1M acetic acid-Ca acetate buffer with a pH of 4.75. Afterwards, allow samples to sit at room temperature for 20-24 hours before briefly centrifuging and removing the solution with a clean pipette. Rinse with 1 ml of de-ionised water, vortex, centrifuge and remove the water with a clean pipette, repeat this rinsing step 3-4 times to remove all residual acetic acid.
3. Drying and weighing:

   Insert samples with test tube caps open overnight in an oven set at 60°C. When samples are sufficiently dry transfer between 0.5-1.0mg of weighed extracted apatite to a labelled glass vial and firmly attach a cap. Each vial is labelled before submitting to the Stable Isotope Lab, VU Amsterdam.

4.3.6.2 Bone collagen extraction protocol

1. A selection of samples is made according to depositional context and with a preference for the same elements (e.g. right humerus), ensuring that elements likely do not belong to the same individual.
2. Bone samples must be cleaned with water and dried to make sure no visible dirt is present.
3. Samples are sawed using a hand-held Dremel diamond-tipped rotary blade or crushed to fill test tubes for the subsequent chemical processing. Thick bones such as vertebrae and some long bones are split into smaller pieces to facilitate faster demineralisation of samples.
4. Samples are inserted in pre-weighed test tubes and subsequently weighed again to ascertain the sample weight. A second duplicate set of empty test-tubes are also weighed, as samples will be transferred to them after the demineralisation process and prior to freeze-drying.

The following chemical treatment protocol is a slightly modified version of the procedure outlined by Müldner and Richards (2005).

1. To clean Elkay Ezee filters in deionised water:

Rinse each tube in deionised water and clean the Ezee filter by adding deionised water into a test tube and pushing the filter into it. Leave the filters and tubes to dry in a clean location before labelling and weighing the tubes.

2. Demineralisation process:

   Add crushed bone to a labelled test tube and add enough 0.6 M hydrochloric acid (HCl) solution so that the waterline sits above the bone samples. Place the cap on each tube and vigorously shake before placing each tube in a refrigerator set at 4°C for 48 hours. Every 48 hours carefully pour out the acid solution with care taken not to spill any of the samples, and subsequently change the acid with more 0.6 M HCl solution. Repeat this acid-wash step until no reaction is seen (no bubbles are present) and the bone is of a sponge-like hardness. Once all samples have been demineralised decant the acid solutions and rinse in deionised water, centrifuge at around 2000 rpm for 1 minute, repeating this step 2-3 times to ensure no residual acid solution is present.

3. Removal of humic acids:

   Add 10mL of 0.125 M sodium hydroxide (NaOH) for approximately 20 hours, leaving the samples to sit at room temperature. Do not leave samples for much longer than 20 hours as this step will considerably reduce the collagen yield. NaOH will remove any humic acids present in the samples which are a major decay contaminant. Afterwards decant the solution and rinse in deionised water, centrifuge at around 2000 rpm for 1 minute, repeating this step 2-3 times to ensure no residual NaOH is present.

4. Gelatinisation of samples:

   Add 9ml of HCl pH 3 (0.001 M) and insert samples in an oven set at 80°C for 48 hours.

5. Ezee-filtering:

   Vortex each tube to prevent collagen from collecting at the bottom out of reach of the Ezee-filter. Slowly push the filter into the tube, leaving around half a centimetre above any remaining particulates that are located at the bottom of the tube. Pour the extracted collagen into the spare labelled and weighed tubes.

6. Freeze-drying (lyophilisation):

   Place each sample in a freezer overnight before undertaking the freeze-drying. Cut an adequately sized piece of parafilm that will comfortably fit over the test tube and poke 3-5 holes in the top to allow liquid vapour to escape during the lyophilisation process. Insert samples in a freeze-dryer for approximately 48 hours. Immediately after freeze-drying weigh each tube with the caps on to calculate the collagen yield.

7. Sample aliquot:

   Weight approximately 0.5mg of purified collagen from each sample. Place an empty tin packet on a micro-balance and tare, subsequently insert ~0.5mg of a sample in the tin packet.

Place these in the correct order in the sampling tray, cover and label the tray and submit it to the Stable Isotope Lab, VU Amsterdam.

4.4 Coalescence of archaeozoological and multi-isotopic data with ethnohistoric records, ethnographic analogy and perspectival theory

The combination of archaeozoological and SIR analyses served to establish the treatment of dogs by humans at the sites of El Flaco and El Carril. This empirical data provides avenue for a more holistic interpretation of how certain individuals were treated beyond what can be ascertained purely by examining their depositional context. The establishment of the morphology of dogs via archaeozoological morphometrics, coupled with data pertaining to their diet and provenance acquired from SIR analyses, enabled a biographical reconstruction of the lives of these animals. This information is of much importance in establishing the treatment conferred upon dogs by the human inhabitants of the sites while they were alive. Analysis of the peri-mortem manipulation of remains, the depositional context, and mortality ages of sampled individuals establishes how these animals were treated at death. These results aided in answering the question as to whether some individual animals were subject to cynophagy—the practice of eating dogs—and given that some other individuals were being conferred with personhood as evidenced by their ritual burial, how they were treated differently during their lifetimes accordingly.

Pivotal in questioning why such a dichotomous treatment existed, takings from the early ethnohistorical accounts of ‘Taíno’ treatment of dogs, and analogous information from contemporary lowland South American peoples’ treatment of these animals provided insight into the cultural rationales governing this differential treatment. This information is covered in Chapter Two of this thesis and provides a springboard for interpreting the empirical datasets generated by the archaeozoological and isotopic analyses of material from the studied sites outlined in Chapter Five. Additional to ethnohistoric records and ethnographic analogy, the theoretical approach of Amerindian perspectivism, outlined in Chapter Three, provides another avenue for interpreting the cosmological underpinnings governing human-animal relations by the Amerindian peoples of the studied sites. This perspectival approach is useful for establishing the dualistic transformative aspect of dogs within the pre-colonial Caribbean, being both imbued with personhood as evidenced by the ritual inhumation of some individuals, and with the likely human consumption of others.

Chapter Five: Sites and Materials

5.1 Introduction to the sites and materials

Canis lupus familiaris remains from two pre-colonial sites in the north-western Dominican Republic, El Flaco and El Carril, served as the primary focus of this research, being subjected to both an archaeozoological and multi-isotopic analyses. Additional dog bone samples from Cathédrale de Basse-Terre and Morel in Guadeloupe, and Hope Estate in St. Martin, were also analysed for collagen isotope values. These samples were included to provide some inter-regional and inter-temporal comparisons of dog diets from the Lesser Antilles to individuals from El Flaco and El Carril, however they provide no comparative information regarding morphology, mortality ages and bone surface modification. Therefore, a thorough overview of the archaeological context of these remains has not been included beyond briefly discussing site locations, dates and depositional context relating to whether these additional samples were from burials or non-burial archaeological contexts.

This chapter outlines the biogeography of the immediate and greater region of Hispaniola, providing background to the modern ecological conditions of the sites and the endemic fauna and flora which was likely present during pre-colonial times. Following this are overviews of the two sites that are the primary focus of this research, El Flaco and El Carril in the Dominican Republic, examining the history of archaeological research, the material remains and interpretations of these pre-colonial settlements. Additionally, brief overviews are given of the three Early Ceramic Age sites from the Lesser Antilles from which extra collagen samples have been included. Afterwards, descriptions of the *C. familiaris* samples from El Flaco and El Carril are given, including an assessment of their relative quantities compared to other taxa at the sites, elemental frequencies, the number of individual specimens (NISP), and minimum number of individuals (MNI) at both sites. Finally, the samples targeted for multi-isotopic analysis from El Flaco and El Carril are listed, as well as the additional collagen isotope samples from Cathédrale de Basse-Terre, Morel and Hope Estate.

5.2 Biogeography of the region surrounding El Flaco and El Carril

El Flaco and El Carril are situated liminally to two ecological zones, the Central Subprovince and the Caribbean-Atlantic Subprovince. The modern thermotypical character of the immediate region is infratropical-supratropical, populated with semiarid-humid plant communities that includes cloudy broad-leaved forest, ombrophilous forest, dry forest, and grasslands (Carmona *et al.* 2010).

The island of Hispaniola is characterised by high taxonomic diversity in both flora and fauna and is home to approximately 2050 endemic plant species that inhabit various ecological niches (Mejía

2006). The variety of endemic fauna is considerably rich, and encompass species of reptile, endemic and migratory birds, and small mammals. Endemic herpetofauna include various amphibians and thousands of species of Squamata (lizards, and snakes) which notably include two species of iguana, *Cyclura ricordii*, and *Cyclura cornuta*. Hispaniola is also home to two endemic species of freshwater turtle, *Trachemys decorata* and *Trachemys stejnegeri* (Schwartz and Henderson 1991). As part of the insular Caribbean, Hispaniola is unique in belonging to one of the few oceanic island systems to have been naturally settled by terrestrial land mammals (Turvey *et al.* 2017). Endemic non-volant mammalian fauna once included several species of Rodentia such as hutía (Capromyidae) and Hispaniolan edible rat (*Brotomys* sp.), and Eulipotyphlae including West Indies shrew (*Nesophontes* sp.) and Solenodontidae (Iturralde-Vinent and MacPhee 1999; McFarlane *et al.* 2000).

Several extinctions have occurred during the Holocene, notably with the initial colonisation of the Greater Antilles by humans that likely led to the gradual extinction of ground sloths (Megalonychidae), as well as heptaxodontid rodents such as the giant hutía (Steadman *et al.* 2005; Turvey 2009; *et al.* 2017). The post-AD 1500 extinction event was substantial, affecting much of the endemic mammalian fauna, including such species as the West Indies shrew (*Nesophontes* sp.), the Hispaniolan edible rat (*Brotomys voratus*) and several species of hutía (Hansford *et al.* 2012; MacPhee and Flemming 1999; McFarlane *et al.* 2000). The palaeontological and archaeological evidence suggests that the relative availability of pre-AD 1500 endemic fauna in the Greater Antilles is reflected within the faunal assemblages of pre-colonial indigenous communities.

5.3 Site discussion: El Flaco and El Carril de Valverde

El Flaco and El Carril are two largely contemporaneous pre-colonial settlements located in northwestern Dominican Republic on the island of Hispaniola, which is the second largest in the Caribbean after Cuba (Figure 15). Both sites were excavated by Prof Dr Corinne L. Hofman and Dr Menno P. Hoogland of Leiden University, as part of the ERC-Synergy research project, NEXUS1492. These sites are potentially located near to the theorised location of the 'Ruta de Colon' of which Christopher Columbus and his men may have used to first venture inland into Hispaniola from the short-lived Spanish settlement of La Isabela (Hofman et al. 2018; Thibodeau *et al.* 2007). El Flaco and El Carril are geographically situated in vicinity to the locations of incipient European colonisation efforts, as such they provide valuable insight into the lifeways of indigenous peoples in the region immediately prior to the arrival of Europeans (Hofman and Hoogland 2015; Hofman *et al.* 2018). Both El Flaco and El Carril contain Ostinoid, Meillacoid and Chicoid ceramics, as well as mixed forms (Ting *et al.* 2018). The sites have overlapping radiocarbon dates, ranging between the 10th to 15th centuries AD at El Flaco, and the 11 to 13th centuries AD at El Carril (Hofman and Hoogland 2015;

Hofman *et al.* 2018; Keegan and Hofman 2017; Sonnemann *et al.* 2016; Veloz Maggiolo 1972, 311-313).

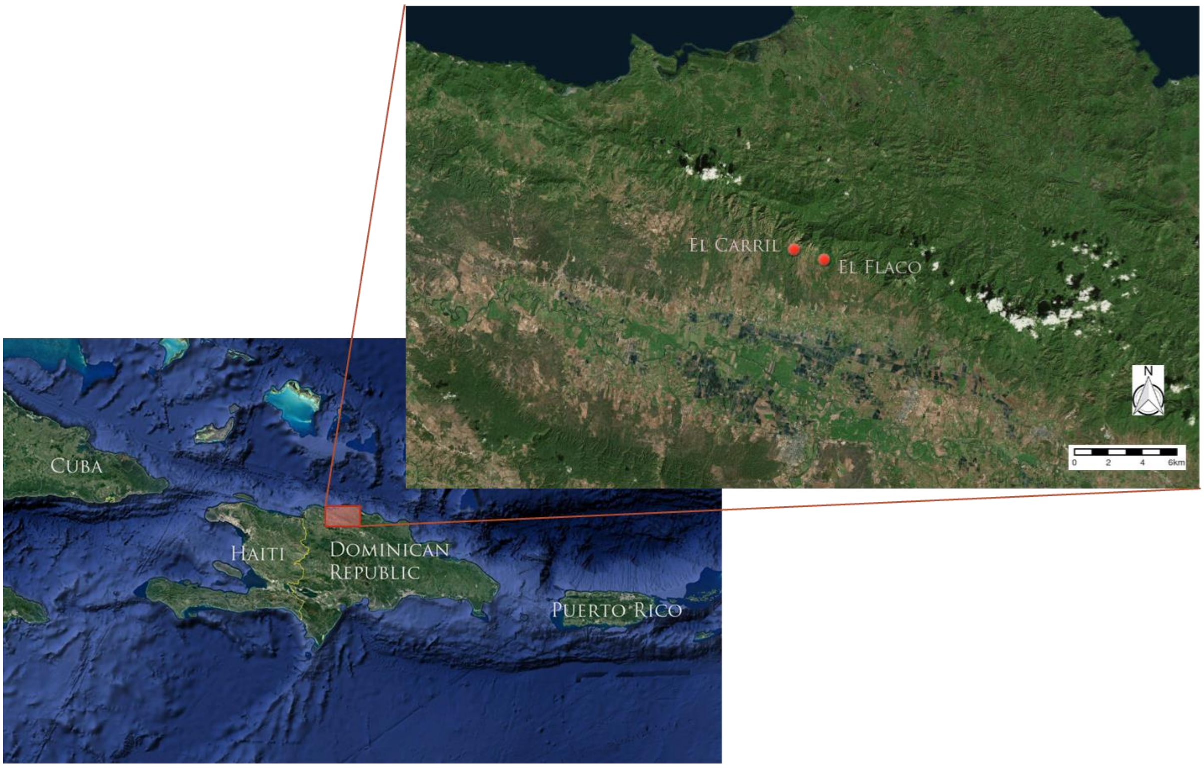


Figure 15: Map showing the location of El Flaco and El Carril within the Dominican Republic

Both sites were found in the province of Valverde and are situated in the southern foothills of the Cordillera Septentrional and are located approximately 12km south of the northern littoral zone (Hofman and Hoogland 2015). The Cordillera spans northwest to southeast from Montecristi to Gran Estero, dividing the northern Atlantic littoral zone from the fertile Cibao valley that runs through the centre of the island (Carmona *et al.* 2010; Herrera Malatesta 2018; Ulloa Hung 2014). The sites largely lie within the same biogeographic zones, with El Carril located approximately 2-3 km west-northwest of El Flaco (Sonnemann *et al.* 2016).

The surrounding region of northern Hispaniola has seen longstanding inhabitation spanning from the early Lithic Age to the Late Ceramic Age (Keegan and Hofman 2017, 40-42, 115-147; Veloz Maggiolo 1981, 10; Ting *et al.* 2016). The region was likely extensively settled by indigenous Caribbean peoples, and archaeological sites have commonly been identified due to their peculiar topographies that indicate anthropogenically flattened areas and raised mounds (Hofman and Hoogland 2015; Hofman *et al.* 2018; Sonnemann *et al.* 2016; Ulloa Hung and Herrera Malatesta 2015).

5.3.1 El Flaco overview

El Flaco is situated at the southern end of the Paso de Los Hidalgos, a pass running through the Cordillera Septentrional that separates the northern littoral zone from the central Cibao Valley. The site is characterised by several flattened platform areas that likely represent residential areas. These flattened areas are encircled by earthworks and multifunctional mounds that are comprised of both refuse deposits and agricultural areas (Hofman and Hoogland 2015; Keegan and Hofman 2017, 128). Situated on top and within these platforms are evidences of housing structures in the form of postholes, with some examples of larger housing layouts measuring approximately 9 m in diameter. The larger of these residences consisted of double rows of supporting posts with a 6 m diameter between the larger internal post holes, whilst the outer ring consisted of both small and larger posts. Also uncovered were cooking areas that contained internal hearths and which demonstrated diameters measuring 3-4 m according to the spacing of postholes (Hofman and Hoogland 2015; Hofman et al. 2018; Keegan and Hofman 2017, 128-9).

The stratigraphy of mounds at El Flaco is complex, with lenses often containing waste materials such as faunal material and considerable quantities of land snail (*Pleurodontes* sp.). Some lenses were burnt, demonstrating fine ash layers that were likely very fertile and may have served as productive kitchen gardens. These mounds were multifunctional, and contain remnants of habitation activities, burials, and served as refuse areas.

At El Flaco, 18 human burials were recovered in three of the excavated mounds. The manner of burial was diverse, and it was likely that graves were left open to allow observed desiccation of the deceased. One burial consisted of a composite of two sub-adults with both crania having been removed after burial. Recovered in association with the human burials were the interred remains of a cranium and pelvic bones of a dog (FND 2270) (Hofman et al. 2018; Keegan and Hofman 2017, 130). Within the mounds at El Flaco, fragmented human and dog remains are distributed throughout (Hofman and Hoogland 2015). All dog remains recovered during excavations at El Flaco have been analysed as part of this research.

5.3.2 El Carril overview

El Carril is situated at the southern end of a narrow pass that runs through the Cordillera Septentrional. According to the findings of drone surveys the settlement extends over a larger surface area than El Flaco, likely covering an area approximately 500 m in length. The site contains the highest number of earthen works than any other previously surveyed indigenous settlement in northern Hispaniola (Hofman and Hoogland 2015). El Carril is currently divided by a modern road, whilst the the larger southern portion of the site is defined by a broad ridge with a relatively flat surface (Sonnemann *et al.*

2016). Veloz Maggiolo previously surveyed El Carril in the early 1970s, with limited test excavation in the northern section revealing the remains of one *C. familiaris* individual, currently housed at the Museo Centro León, Santiago de los Caballeros. The site was originally estimated to contain 124 mounds as determined from surface survey and aerial photographs (Veloz Maggiolo 1972, 311-313). Recent photogrammetric survey by the NEXUS team has greatly reduced that number to 42 mounds surrounding 78 largely flat circular areas (Hofman et al. 2018; Sonnemann *et al.* 2016). Excavations conducted by Leiden University in 2017 targeted the area to the south of the dividing modern road, uncovering evidence of settlement areas, refuse deposits, and possibly raised kitchen gardens (*conucos*). Similar to El Flaco, fragmented human and dog remains are seemingly randomly dispersed throughout excavated middens. All *C. familiaris* remains recovered during the 2017 season have been analysed as part of this research.

5.4 Comparative examples from Lesser Antillean sites - Morel and Cathédrale de Basse-Terre, Guadeloupe, and Hope Estate, Saint-Martin

Further dog bone samples were obtained courtesy of Dr Sandrine Grouard from the Muséum National d'Histoire Naturelle (MNHM), Paris, for the purposes of collagen analysis. These additional samples were collected from the sites of Morel, Grande-Terre and Cathédrale de Basse-Terre, Basse-Terre in Guadeloupe, and Hope Estate in St. Martin. These additional samples serve to provide pan-Caribbean palaeodietary comparisons from Early Ceramic Age sites from the Lesser Antilles to that of the Late Ceramic Age Hispaniolan sites of El Flaco and El Carril. They also provide extra correlative data to assess whether there are linkages between depositional context (i.e., burial or non-burial) and differential treatment affecting the treatment of some dogs by humans as indicated by their diet. Brief descriptions of the locations, occupation dates, archaeological cultures of these sites are given below, alongside a description of the depositional context from which these dog remains were recovered.

5.4.1 Morel, Grande-Terre, Guadeloupe

The site of Morel is situated along the northeast coast of the island of Grande-Terre, Guadeloupe. Archaeological investigations have been conducted since the mid-twentieth century and have determined an extensive occupation range of 300 BC to AD 1400 (Bullen and Bullen 1973; Clerc 1968; Hofman *et al.* 1999; 2014). The ceramic component of the site indicates a mixture of Huecoid and Cedrosan Saladoid ceramics, the usage of which was likely contemporaneous as indicated by their mutual presence within the same archaeological levels (Hofman *et al.* 1999; 2014).

Rescue excavations conducted during the 1990s by the Direction Régionale des Affaires Culturelles of Guadeloupe and Leiden University recovered a total of 10 human and 15 animal burials, 14 of which were of *C. familiaris* (Grouard 2001; Hofman *et al.* 1999). The large amount of human and dog co-burials evident at Morel is rare for the pre-colonial Caribbean and is only mirrored in the significant amount of dog burials that have been excavated at the contemporaneous Greater Antillean sites of La Hueca-Sorcé on Vieques and Punta Candelero on Puerto Rico (Laffoon *et al.* 2015). The dog bone samples from Morel (n=6) obtained for this research are from burial contexts (

Table 10).

5.4.2 Cathédrale de Basse-Terre, Basse-Terre, Guadeloupe

Located in Guadeloupe in the south of the volcanic island of Basse-Terre is the site of Cathédrale de Basse-Terre. The site is rich in malacofauna and vertebrate fauna and exhibits significant proportions of ceramics. Recovered at the site were Huecan-Saladoid and Cedrosan Saladoid ceramics from the same stratigraphic units. Cathédrale de Basse-Terre, like much of Guadeloupe, was likely occupied by ceramic-bearing horticulturalists during the Early Ceramic Age, beginning around 200 BC (Bérard 2010; Bochaton *et al.* 2016; Bonnissent and Romon 2004; Grouard 2010). Stylistic similarities in the ceramic assemblages of Cathédrale de Basse-Terre indicates contemporaneity and cultural linkages with other Early Saladoid sites in Guadeloupe, such as Gare Maritime, Anse Sainte-Marguerite, Folle-Anse in Marie-Galante and Morel, and Hope Estate on St. Martin (Romon 2006).

Dog remains from Cathédrale de Basse-Terre were found both in domestic contexts (Grouard *et al.* 2013) and in burials (Bonnisent and Romon 2004). Sandrine Grouard (*et al.* 2013) has previously calculated the shoulder height of one individual (CBT 5002) that underwent stable isotope analysis as part of this research. The height of this individual, amongst others, has been included in Chapter Six: Results to provide a comparison to the heights of dogs from El Flaco and El Carril. The two dog bone collagen samples from Cathédrale de Basse-Terre analysed in this research are from burial contexts (

Table 10).

5.4.3 Hope Estate, Saint-Martin

The pre-colonial site of Hope Estate is in the northeast of the island of St Martin. This pre-colonial settlement was situated on a plateau overlooking an alluvial plain and the salt ponds of Grand' Case and Chevrise (Bonnissent *et al.* 1997). Hope Estate is unusual for the pre-colonial Lesser Antilles due to its inland location. The site has been excavated by Haviser (1989) and by Hofman and Hoogland (1999) and later by Bonnissent (2008). This site comprises a chronological succession of Amerindian villages and is surrounded by refuse deposits that contain both Huecan Saladoid and Cedrosan Saladoid ceramics, indicating an occupation range of 500 BC - AD 700, and therefore is possibly contemporaneous with Cathédrale de Basse-Terre and Morel in Guadeloupe (Bonnissent *et al.* 1997; 1999; Grouard 2004).

The faunal assemblage is represented by 75 different taxa, all of which were likely consumed by the indigenous inhabitants of Hope Estate, including dog (Grouard 2004). *C. familiaris* individuals that were recovered at Hope Estate (MNI=7) were from refuse areas and were relatively complete, although with a larger representation of bones from fleshy areas, such as forelimbs and the posteriors of these animals. Extremities were largely absent from the assemblages (Grouard 2004). The collagen samples that was processed as part of this research (HE 2009E, HE 2503C, HE 3305B) are from refuse contexts and are likely the remains of dogs that were consumed by the Amerindian inhabitants of the site (

Table 10).

5.5 *Canis lupus familiaris* samples

At El Flaco, all faunal remains recovered during the 2016 season were sorted and recorded by the author, adding to information that was previously recorded by other researchers during the 2013-2015 field seasons. All the vertebrate faunal material from the 2017 excavation at El Carril has been sorted and recorded personally by the author. Considering that an analysis of all taxa from El Flaco and El Carril does not bear relevancy to answering the outlined research questions, only *C. familiaris* remains have been qualitatively analysed as part of this research.

The number of dog remains from El Flaco and El Carril is minimally present compared to the abundant quantities of other faunal remains present at both sites. The majority of *Canis lupus familiaris* specimens were recovered as individual elements within archaeological contexts associated with refuse areas or *conucos*. Dog remains account for less than 1% of the NISP at El Flaco and at El Carril. For a list of all other identified fauna including NISP and recorded weight information from El Flaco and El Carril please refer to Appendix A.

5.5.1 MNI, NISP, elemental frequency

At El Flaco, a total of 33 individual *C. familiaris* specimens (NISP = 33) were recovered from the site, the majority of which (81.8%) are fractured or incomplete. Some of the incomplete bones demonstrate evidence that ossification was not complete at the time of death, indicating that these individuals had not reached full developmental maturity. During the initial sorting any refitting bones were counted as one NISP. The only complete bones (n=5) recovered from El Flaco were a refitting left 5th metacarpal and proximal phalanx (FND 2821) a refitting middle phalanx and ungual phalanx (FND 2838), and an interred upper skull (FND 2270) that was counted as complete as only a small portion of the right zygomat was fractured off (Figure 16c, d). This last element was found in association with two refitting innominates, the right side of which was missing the pubis bone (Figure 16). Cranial elements comprise 18.2% of the assemblage (n=6), long bones 18.2% (n=6), axial elements including rib fragments and vertebrae account for 24.2% (n=8), whereas loose teeth account for 18.2% (n=6).

Three mandibles and three maxilla contained teeth, allowing the MNI to be easily calculated. A total of three maxillae were recovered, one of which was complete (FND 2270). A minimum number of individuals of three (MNI = 3) *C. familiaris* were recovered at El Flaco has been calculated according to the presence of these cranial elements. Due to the possibility of pre- and post-depositional redistribution of elements throughout the site due to cultural or natural processes, such as sweeping activities, trampling or bioturbation (Olsen and Shipman 1988), archaeological context has been disregarded as a factor in calculating the MNI.


(a) (b) (c) (d) (e) (f)

Figure 16: Faunal remains from El Flaco including the two complete podial elements and interred upper skull and innominate bones; (a) FND 2821 including complete left 5th metacarpal and proximal phalanx; (b) FND 2938 complete middle phalanx and ungual phalanx; (c) FND 2270 almost complete skull from ritual deposit, left lateral view (d) skull, top view; (e) FND 2270 innominates from ritual deposit, anterior view; (f) innominates, posterior view (copyright NEXUS1492, photographed by author)

Excavations at El Carril recovered a total NISP of 29 *C. familiaris* remains. Of all specimens, only three were complete; a right 5th metatarsal (FND 424), and a right and a left tibia (FND 419, 424), all three of which belonged to a largely disarticulated partial skeleton recovered from three adjacent excavation units (FND 396, 419, 424). This partial skeleton is comprised of the upper and lower right limbs of an individual, and portions of both scapulae, and accounted for 58.6% of all identified *C. familiaris* specimens from El Carril (Figure 17, Figure 18). There were no associated axial or cranial elements found in context with these remains. Due to the scattered distribution of elements over a horizontal axis 3 m^2 and given that only a limited number of appendicular elements are represented, the possibility that this individual animal was intentionally buried has been discounted.

Figure 17: Reconstructed *C. familiaris* partial skeleton recovered from Unit 10, El Carril (FND 396, 419, 424) (copyright NEXUS1492, photographed by author)

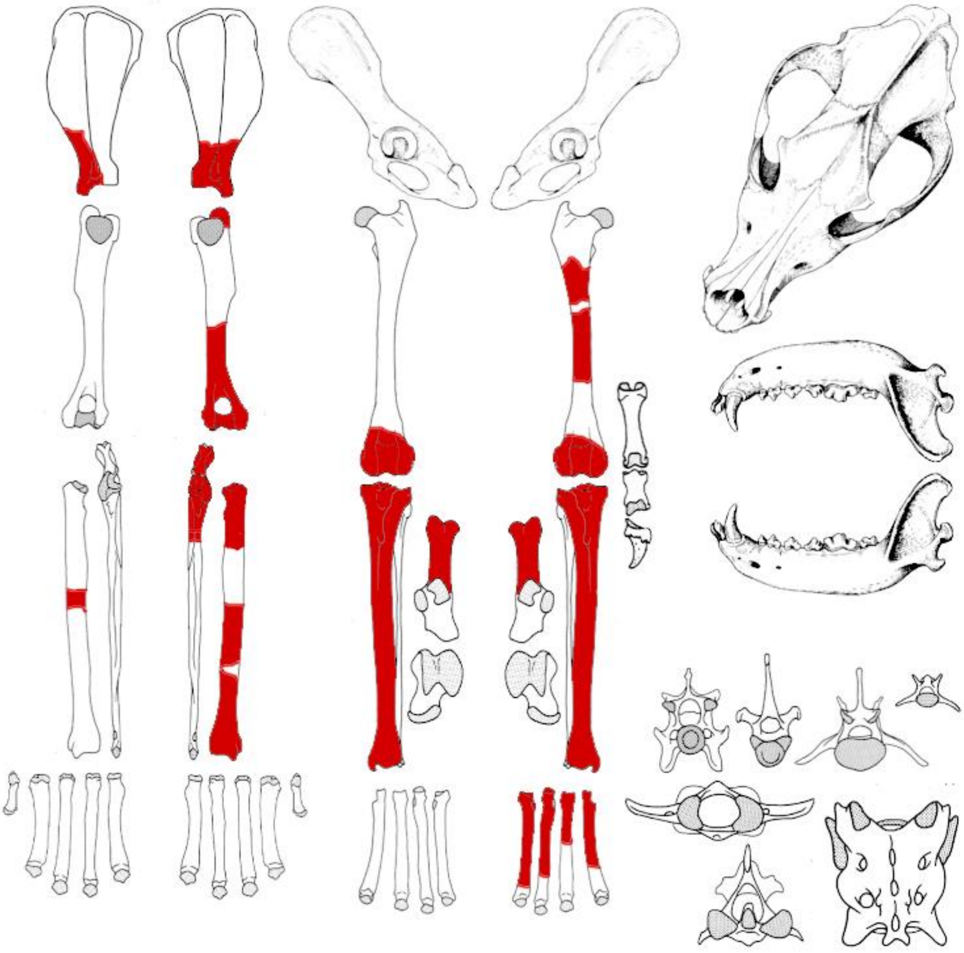


Figure 18: *C. familiaris* skeletal elements represented in red contained within the partial skeleton recovered from Unit 10, El Carril (FND 396, 419, 424) (copyright NEXUS1492, created by author)

The El Carril element distribution is comprised of 6% cranial elements (n=2) including a right mandible with fresh breaks on the frontal portion and mandibular coracoid (FND 729) and containing the tooth row from the second premolar to the second molar (Figure 19). Long bones account for 37.9% of the assemblage (n=11), followed by podial elements (n=7, 24.1%) and loose teeth (n=7) four of which were lower canine teeth. Finally, two scapulae fragments are represented in the partial skeleton. In calculating the MNI of El Carril, 17 of these elements have been determined to belong to the same individual as represented in the partial skeleton. All other elements could possibly belong to one other individual as they are not repeated elements. Therefore, at El Carril the minimum number of *C. familiaris* individuals is two (MNI=2). For a detailed list of all *Canis lupus familiaris* skeletal elements from El Flaco and El Carril please refer to Appendix B, and for photographs of these same samples please refer to Appendix C.

Figure 19: FND 729 from El Carril, partial right mandible containing four teeth. Collagen and enamel extraction was conducted on this sample (copyright NEXUS1492, photographed by author)

5.5.2 Depositional context of *C. familiaris* remains at both sites

At both El Flaco and El Carril, most elements were isolated finds, scattered amongst other faunal and cultural material as well as fragmented human remains. The partial skeleton from El Carril, which is predominantly comprised of appendicular elements (FND 396, 419, 424) is taken to represent the same individual. This individual was found scattered across three 1x1 m excavation units in the upper 30 cm of Unit 10, which contained several housing units evidenced in postholes in the lower strata. This has not been treated as a ritual burial due to the absence of cranial and axial elements and because of the relatively wide horizontal and vertical dispersal of refitting elements. The reasons for this wide dispersal is unknown, but may be resultant of cultural processes during occupation of the site, or due to post-depositional taphonomic processes.

At El Flaco, the only buried remains are a mostly complete upper skull and two pelvic bones (FND 2270). The upper skull was found to be overlying the two innominates within a depositional context associated with human burials in Unit 61, it therefore likely represents a purposeful interment symbolically linked to the burial of humans (Hofman 2017, *pers. comm*). FND 2270 serves as the only example of a buried individual dog at both sites, excluding the previously excavated dog burial from El Carril which was not accessible for this research.

5.5.3 Isotope samples

Selections of samples were made of loose teeth and skeletal elements from both sites. Where applicable, mandibles or maxillae that contained teeth were chosen to analyse the collagen and enamel values from the same individual. A total of 19 elements were chosen for bone collagen extraction from the two Dominican sites, ensuring that the same individual was not repeatedly sampled; these included five from El Carril and 14 from El Flaco (Table 8). For dental enamel samples (n=13), six are from El Flaco and seven from El Carril (Table 9).

A further 15 collagen samples were processed from the sites of Hope Estate, Saint-Martin, and Cathédrale de Basse-Terre and Morel in Guadeloupe (

Table 10). These samples were included to provide a regional comparison between the isotopic signatures of dogs from the Lesser Antilles and those from Hispaniola, and to provide added information to assess if there are any key differences in dietary intake between dogs that were recovered from burial deposits compared to those from non-burial contexts.

Table 8: Bone collagen sample list of *C. familiaris* remains from El Flaco and El Carril

Bone collagen samples from Hispaniola for δ^{15}N and $\delta^{13}C_{co}$ analysis			
Site	**Find number**	**Element**	**Description**
El Flaco	FND 731	Right humerus	Distal fragment, unfused
El Flaco	FND 2270	Cranium	Mostly complete upper skull, zygomat sampled
El Flaco	FND 2610	Right ulna	High degree of weathering, missing olecranon
El Flaco	FND 2649	Left femur	80% complete, partially fused epiphyses
El Flaco	FND 2801	Right 4th metacarpal	Distal 40% of bone
El Flaco	FND 2812	Left radius	Distal epiphysis
El Flaco	FND 2821	Left 5th metacarpal	Complete bone
El Flaco	FND 2828	Left maxilla	Fragment containing sockets for tooth row P_2 - M_1
El Flaco	FND 2838	Left radius	70% of shaft, missing distal portion
El Flaco	FND 3050	Thoracic vertebra	One of two found in the same context, likely refit
El Flaco	FND 3170	Lumbar vertebra	Missing transverse process
El Flaco	FND 3261	Left mandible	Distal fragment, contains P_3, no P_4 and has an erupting M_1
El Flaco	FND 3491	Mandible	Crushed puppy mandible
El Flaco	No find nr.	Left ulna	Unfused proximally
El Carril	FND 424	Left 5th metatarsal	Distal epiphysis fractured off. Part of partial skeleton.
El Carril	FND 716	Left humerus	Distal shaft fragment, missing epiphyses
El Carril	FND 722	Left ulna	Mid-diaphysis fragment
El Carril	FND 729	Right mandible	Contains tooth row P_2-M_2

El Carril	FND 771	Maxilla	Fragment of right portion of maxilla

Table 9: Dental enamel sample list of C. familiaris remains from El Flaco and El Carril

Dental enamel samples from Hispaniola for $\delta^{13}C_{en}$, $\delta^{18}O$ and $^{87}Sr/^{86}Sr$ analyses			
Site	**Find number**	**Element**	**Description**
El Flaco	FND 2270	Left C^1	Upper canine from interred dog skull
El Flaco	FND 2812	Right P^1	Upper right first premolar
El Flaco	FND 2828	Left I^2	From maxilla fragment
El Flaco	FND 2838	Right P^2	Distal cusp and root, lingual section fragmented off
El Flaco	FND 3261	Left dp^4	Deciduous fourth premolar from maxilla fragment, juvenile animal
El Flaco	FND 3269	Left dp_4	Lower deciduous fourth premolar associated with two small mandibular fragments and two incisors (I_2)
El Carril	FND 30	Left P^2	Missing proximal cusp and root
El Carril	FND 687	Right M_1	Fully formed lower first molar, little to no wear
El Carril	FND 701	Right C^1	Fully formed upper canine
El Carril	FND 716	Right C^1	Fully formed upper canine
El Carril	FND 722	Left C_1	Fully formed lower canine
El Carril	FND 729	Right P_2	Sampled from a mandible
El Carril	FND 903	Right C_1	Lower canine, root fractured off

Table 10: *C. familiaris* remains supplied courtesy of Dr Sandrine Grouard. Included in this table are the sites, elements and depositional context of the remains

Bone collagen samples from the Lesser Antilles $\delta^{15}N$ and $\delta^{13}C_{co}$ analysis			
Site, Region	**Find number**	**Element**	**Depositional context**
Morel, Guadeloupe	2675	Rib	Burial
Morel, Guadeloupe	2727	Rib	Burial
Morel, Guadeloupe	2728	Rib	Burial
Morel, Guadeloupe	2729	Rib	Burial
Morel, Guadeloupe	2730	Rib	Burial
Morel, Guadeloupe	2731	Rib	Burial
Morel, Guadeloupe	2732	Nasal fragment	Burial
Morel, Guadeloupe	2734	Cranial fragment	Burial
Cathédrale de Basse-Terre, Guadeloupe	CBT US/UD 3008	Rib	Burial
Cathédrale de Basse-Terre, Guadeloupe	CBT 5002	Vertebra	Burial
Hope Estate, Saint-Martin	HE 2009E	Long bone fragment	Refuse
Hope Estate, Saint-Martin	HE 2302BB	Vertebra	Refuse
Hope Estate, Saint-Martin	HE2503C	Long bone fragment	Refuse

Hope Estate, Saint-Martin	3305	Rib	Refuse

Chapter Six: Results

6.1 Results of archaeozoological analysis

This section contains the results of the archaeozoological analysis based on the morphometric data of all diagnostic traits from each applicable element, according to the standardised procedures outlined by von den Driesch (1976). These measurements are listed in Appendix B. Listed below are the individual specimens that exhibited possible indications of butchery, followed by the estimated mortality age profiles, and the results of the morphological reconstructions of shoulder height and mass of dogs from El Flaco and El Carril. Where applicable, morphological reconstructions were compared to that of previously recorded data from dog burials throughout the insular Caribbean.

6.1.1 Bone surface modification

Of the 62 individual elements uncovered from both sites there was minimal evidence of intentional bone surface modification, either in the form of cut marks or of fracture patterns that could be unequivocally linked to the intentional peri-mortem fracturing of remains. There is no evidence on any skeletal elements of percussion notches that would indicate the purposeful fracturing of bones for marrow extraction. Most of the elements examined demonstrate regular transverse fractures and do not bear clear evidence of peri-mortem manipulation by humans. No macro-observable burning or cooking traces are apparent on any of the elements.

There are a limited number of elements (n=2) from El Carril that potentially demonstrate bone surface modification, both of which are tibiae from the same individual (Figure 20). None of the *C. familiaris* remains uncovered from El Flaco exhibited clear markings that could be safely attributed to butchery or cooking practices.

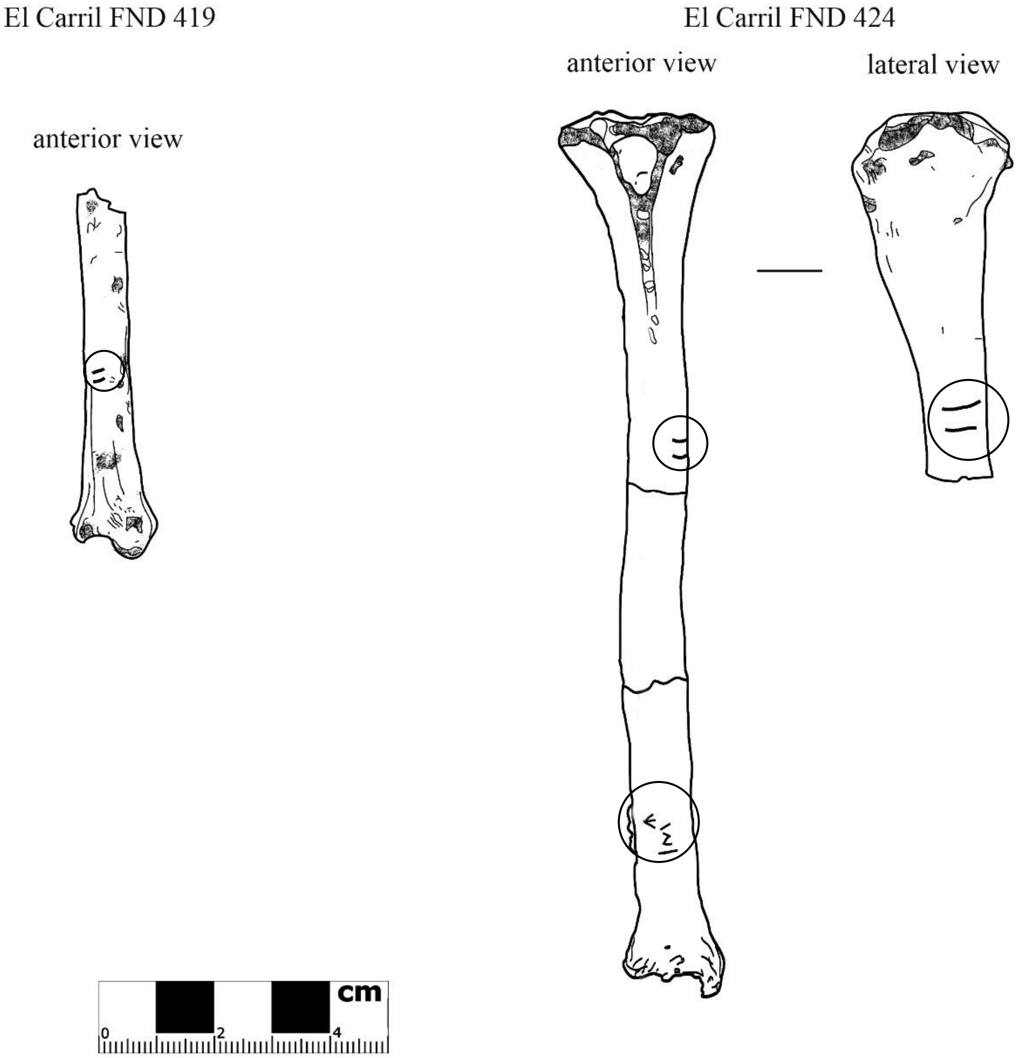
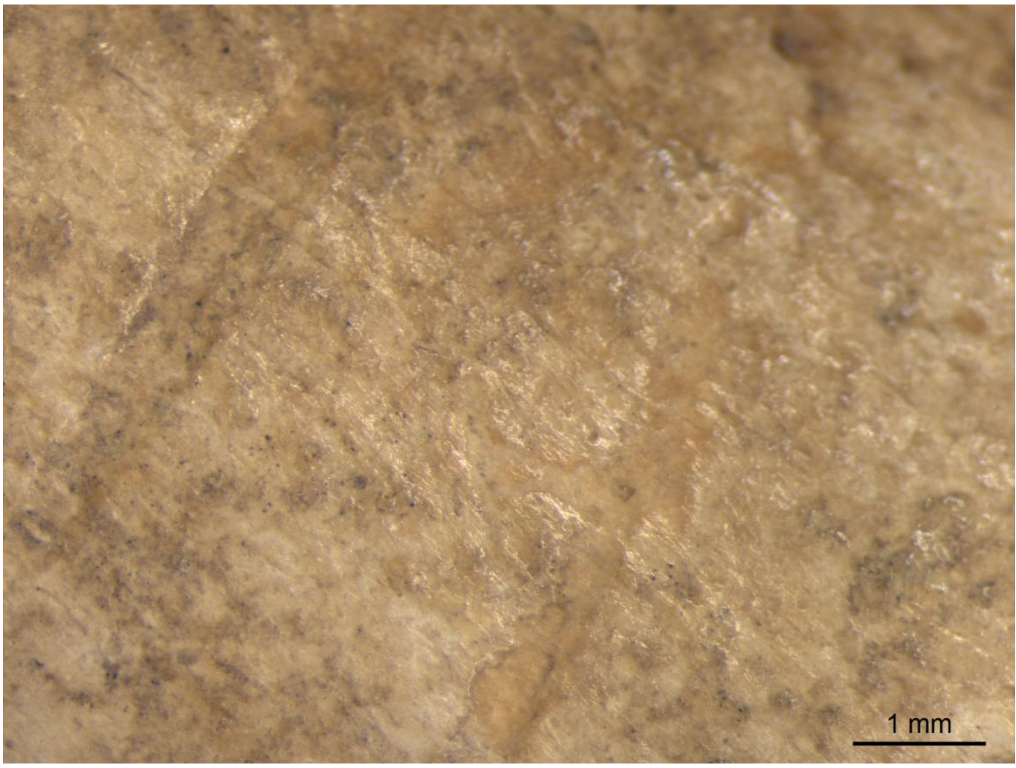


Figure 20: Two elements from El Carril exhibiting possible butchery marks; a right tibia distal fragment (FND 419); a complete refitting left tibia (FND 424) with markings on the proximal and distal fragments.

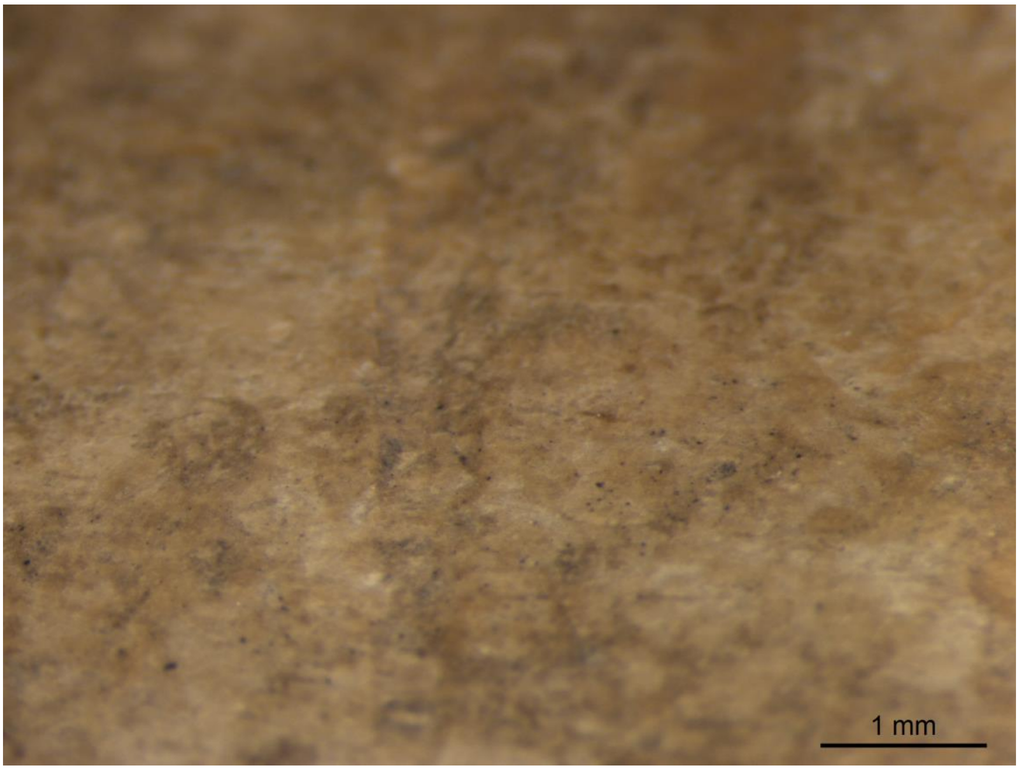
El Carril FND 424 - Left tibia from the partial skeleton

Find 424, a left tibia belonging to a partial skeleton uncovered from Unit 3 at El Carril exhibited two parallel, linear markings located at the distal end of the proximal shaft fragment (Figure 21). These markings are situated 53 mm below the proximal termination of the bone and are evidently shallow in cross-section. However, their parallel arrangement in a medio-lateral direction suggests that intentional butchery may have occurred on this element. Given the uniformity of their arrangement human modification is a distinct possibility, however the shallowness of the grooves is suggestive that a non-lithic tool would have been utilised. The use of shell is a possibility, although this is an uncertain given that the internal grooves lack any striations that may possibly be expected if shell was used as a laceration tool.

(a)



(b)



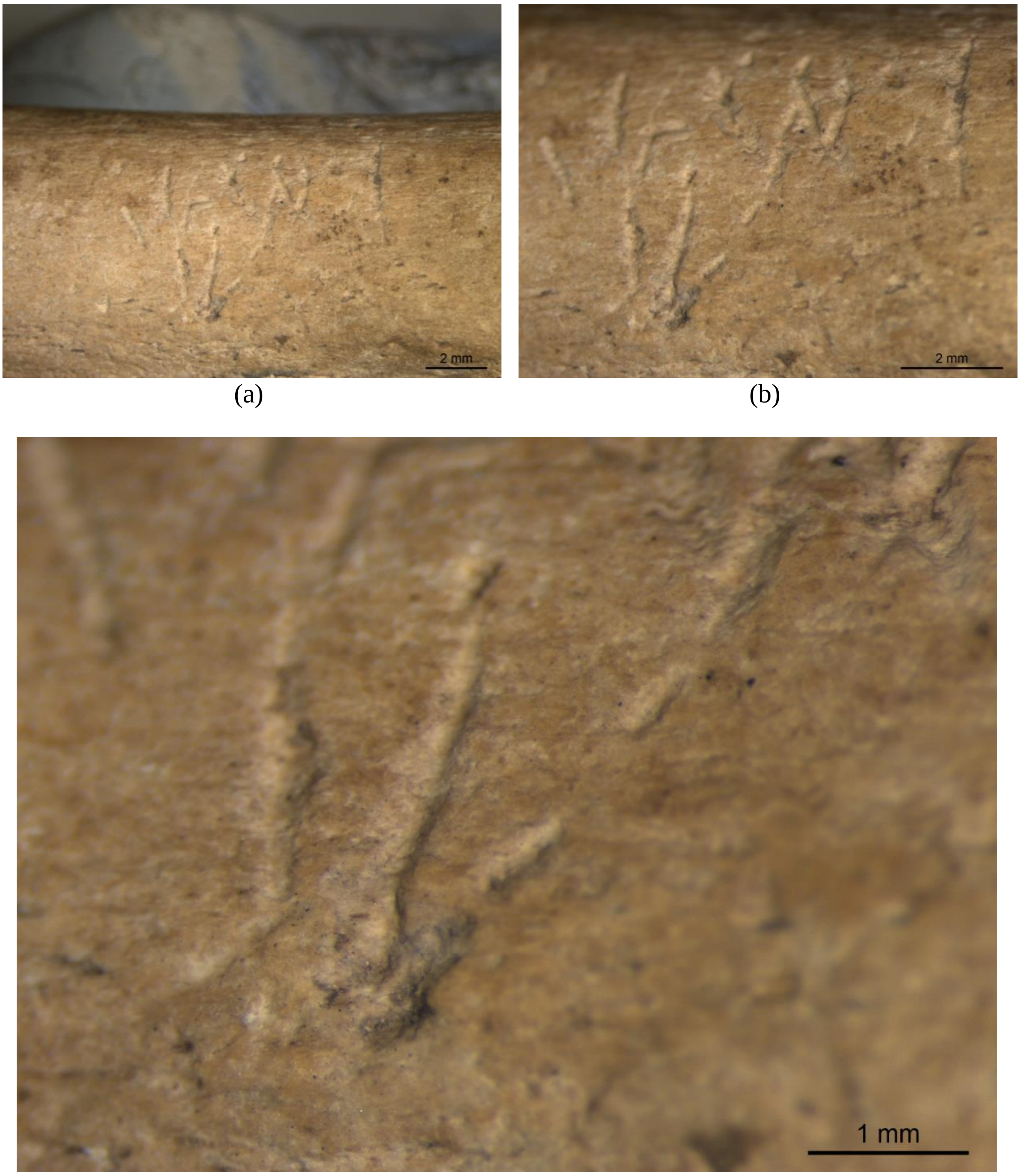
(c)

Figure 21: Magnified bone surface modification markings on a left tibia proximal fragment (FND 424) (a) FND 424 at 0.75x magnification; (b) 1.6x magnification; (c) 2.0x magnification (copyright NEXUS1492, photographed by Tom Breukel)

The distal fragment of the same element exhibits overlapping markings on the dorsal surface, located 28 mm from the distal termination of the bone (Figure 22). These are possibly the result of gnawing action by a small scavenger, indicated by the presence of pitting and furrowing marks at the commencement of these linear markings. The presence of internal striations and the irregular arrangement of these markings is indicative of repetitive action by an animal with a bite force that was not strong enough to form puncture marks (Binford 1981, 44-48), therefore this action was unlikely undertaken by a dog. This bone has been fractured in three places, although it is likely that this is due to post-depositional processes as there are no percussion scars to indicate purposeful hammerstone fractures.

El Carril FND 419- Right tibia from the partial skeleton

This specimen is a distal right tibia fragment from the same individual as FND 424 (Figure 23). Situated on the lateral margin of the distal shaft, approximately 36mm from the termination of the distal epiphysis, are two small parallel marks oriented in a medio-lateral direction. Again, these markings are likely not created by a lithic tool. Shell is a possibility, although the highly-eroded nature of the bones prevents more accurate identification, as any possibly internal striations within the grooves may be diminished due to taphonomic effects.



(a) (b)

(c)

Figure 22: Magnified bone surface modification markings on a left tibia distal fragment (FND 424) (a) FND 424 at 0.75x magnification; (b) 1.6x magnification; (c) 2.0x magnification (copyright NEXUS1492, photographed by Tom Breukel)

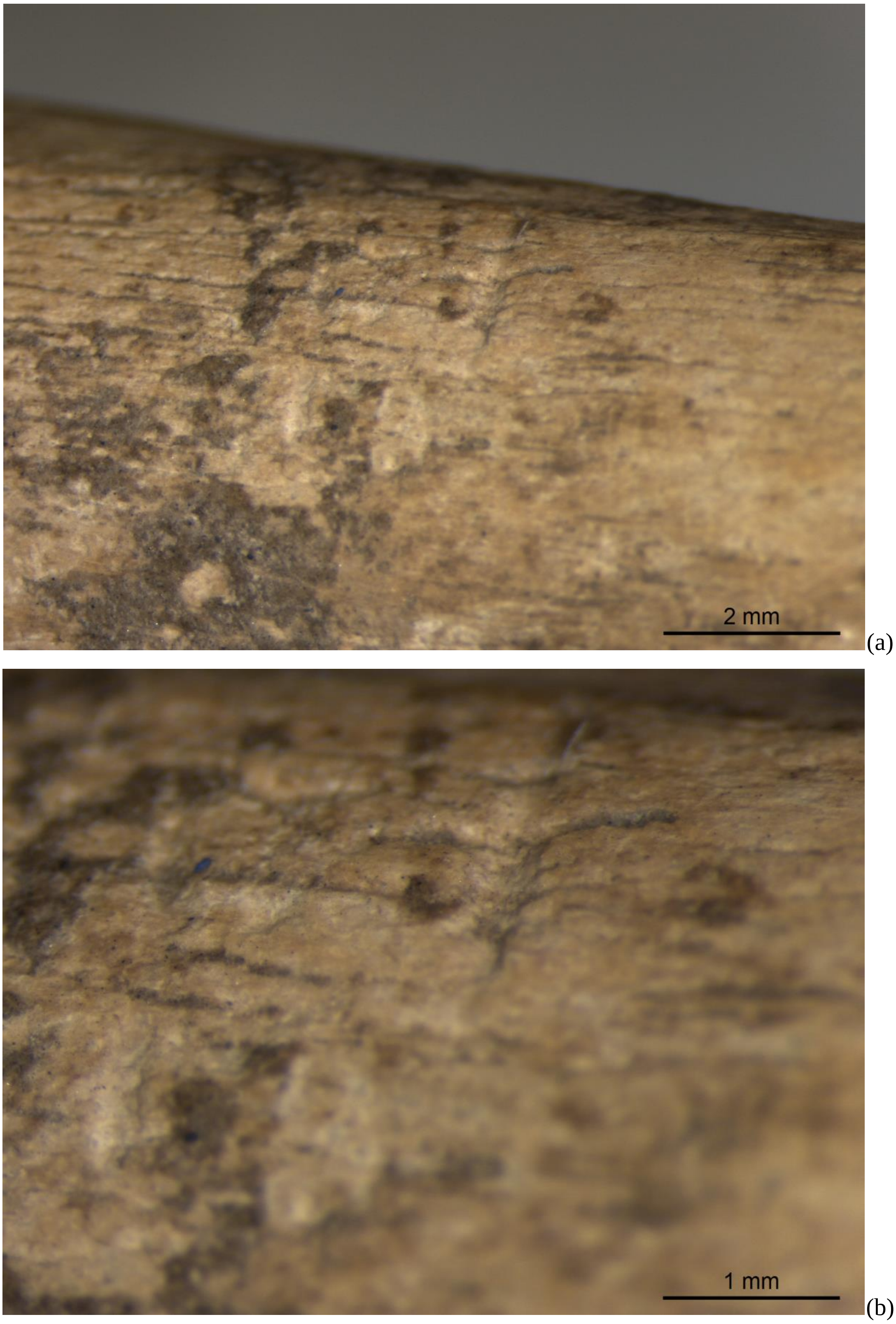


Figure 23: Magnified bone surface modification markings on a right tibia distal fragment (FND 419) (a) FND 419 at 0.75x magnification; (b) 1.6x magnification; (c) 2.0x magnification (copyright NEXUS1492, photographed by Tom Breukel)

6.1.2 Mortality age profiles

Twenty-Eight *C. familiaris* elements from El Flaco and El Carril were applicable for age estimations, including several elements from the partial skeleton uncovered in Unit 10 at El Carril. All teeth (n=13) are counted within this, including loose teeth, and mandibles and maxillae that contained fully-formed teeth sockets which serve as an indication that dental eruption had occurred. For samples that contained tooth rows, the latest erupting tooth was used as the basis for calculating mortality age. Individual bones (n=16) that exhibited one or both diaphyses were applicable for mortality age estimation. As the age of full dental maturity in *C. familiaris* occurs at the earliest at five months of age, most of the mortality ages calculated from teeth only indicate five months as a minimum age and therefore give no specificity as to the maximum mortality age of those individuals.

6.1.2.1 El Flaco mortality ages

At El Flaco 17 individual specimens were applicable for mortality age estimations (Figure 24). The proportion of juvenile or subadult individuals compared to mature individuals is higher than what is observed at El Carril, with 41.17% (n=7) of the samples belonging to individuals that were definitively younger than 9 months of age (Figure 24; Figure 25). Two elements (FND 3444, 2950) were deciduous canine teeth, which are normally replaced by adult teeth after four months of age (Cornwall (1974, 227). As these elements were isolated finds and no other teeth were associated with them it cannot be accurately deduced if these teeth had been shed from individuals that had survived to a later stage of maturity.

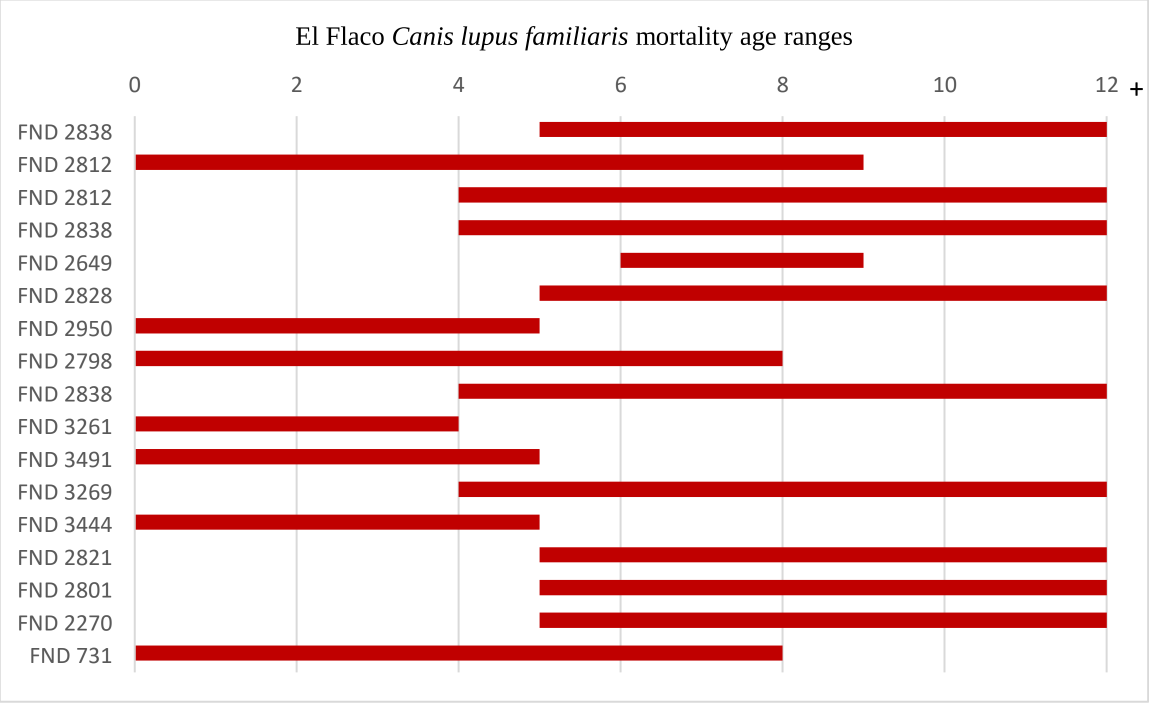


Figure 24: El Flaco mortality age ranges according to each applicable specimen, represented in months

Two mandibular fragments (FND 3261; 3491) belonged to juveniles as all teeth had not erupted.

FND 3261 consists of a mandible fragment and two maxilla fragments, representing a disarticulated portion of a left jaw. One maxilla fragment retained a deciduous fourth premolar, whereas the mandible fragment contained an intact and erupted adult second premolar, as well as a fourth premolar in the process of forming and erupting. The enamel coating for the fourth premolar was not fully formed. This individual animal was aged at 4-5 months at death.

FND 3491 contained an erupted third premolar and an erupting fourth premolar, therefore also indicating 4-5 months of age.

FND 2812 is an unfused distal epiphysis of a left radius that is from an individual younger than six to nine months of age. This individual could therefore be either juvenile or subadult.

A total of 11 individual specimens are designated as at least older than 4-5 months of age, however due to the isolated nature of most finds determining whether these individuals were adult or subadult is not possible. One partially-fused femur (FND 2649), can be more accurately determined to have been aged between 6-9 months death. This specimen demonstrated partial ossification of the greater and lesser trochanters and an unfused femoral head and is missing the distal diaphysis which was likely unfused.

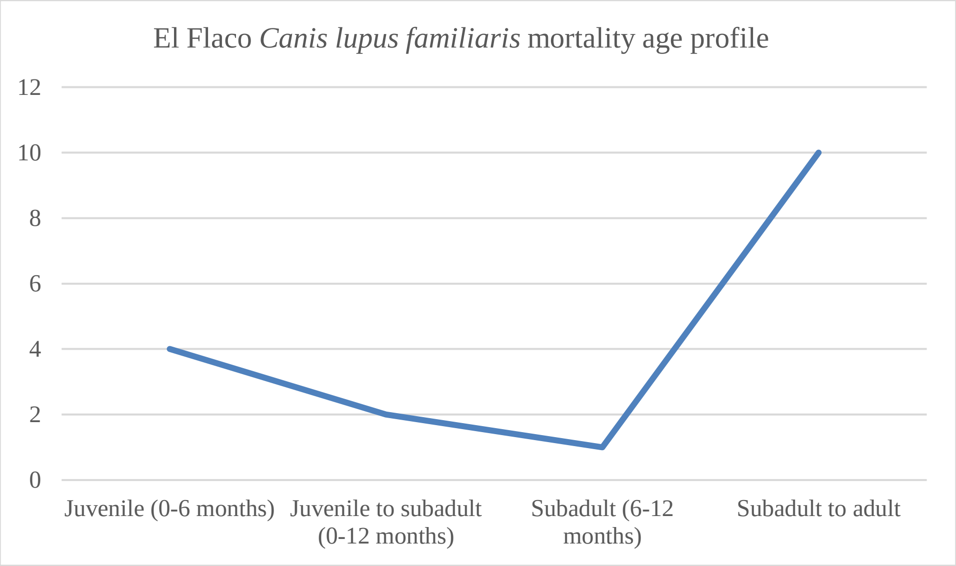


Figure 25: El Flaco mortality age profile

The interred upper skull (FND 2270) is either subadult or adult as all mature teeth cavities were present within the maxilla, indicating an age of at least 5 months. Due to the largely intact nature of the upper skull an analysis of suture closures would possibly allow an estimation of maturity, however given that different dog breeds and grey wolves (*Canis lupus lupus*) both demonstrate highly variable suture fusion ages (Geiger and Haussman 2016), an age determination based cranial suture closure rates was not deemed feasible.

6.1.2.2 El Carril mortality ages

From El Carril a total of 11 specimens were deemed suitable for age estimations, including seven dental elements (including one mandible and one maxilla), two isolated long bones and several elements from the partial skeleton (Figure 26). Of these, one individual specimen, a humeral fragment (FND 716) was likely younger than 5-8 months, representing either a juvenile or subadult animal. One element (FND 722) is an ulna fragment that is proximally unfused at trochlear notch, this was deemed to be younger than 10 months of age and therefore likely belonged to a subadult individual.

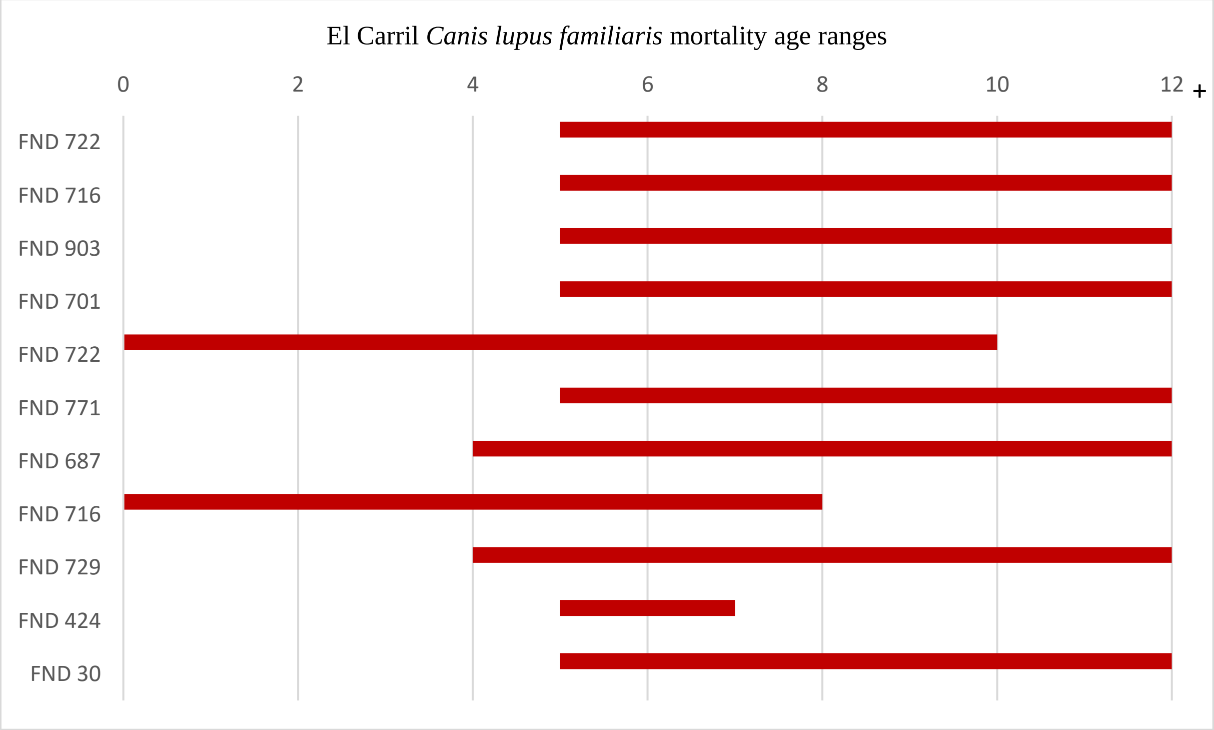


Figure 26: El Carril mortality age ranges, represented in months

The partial skeleton uncovered from Unit 10 (FND 396; 419; 424) demonstrated complete epiphyseal fusion on all intact elements, except for both calcanea. Several elements (n=6) were fractured in a way that did not allow analysis of epiphyseal fusion. These elements include both scapula, whereas both are broken laterally beyond the articulation point they also demonstrate complete fusion of the coracoid process. The head of the left humerus was detached, having likely been unfused to the missing proximal humerus fragment, suggesting that this individual was definitively under 10 months of age. Two complete bones, a left tibia and a left radius possessed both epiphyses and were therefore applicable for age estimations. The proximal epiphysis of a tibia fuses the latest of any long bone at between 6-11 months of age, and both samples exhibited mostly complete proximal ossification. Both calcaneal tubers were not completely fused, which generally occurs between 11 weeks and 7 months of age. In combining expected epiphyseal fusion ages, a more exact mortality age range of 6-7 months of age can be given for the partial skeleton, indicating that this animal was definitively subadult at death.

All other specimens belonged to individuals over at least five months of age. However, given the fractured nature of the assemblage it is not possible to determine whether these individuals were fully mature (over 12 months) or subadult (6-12 months)

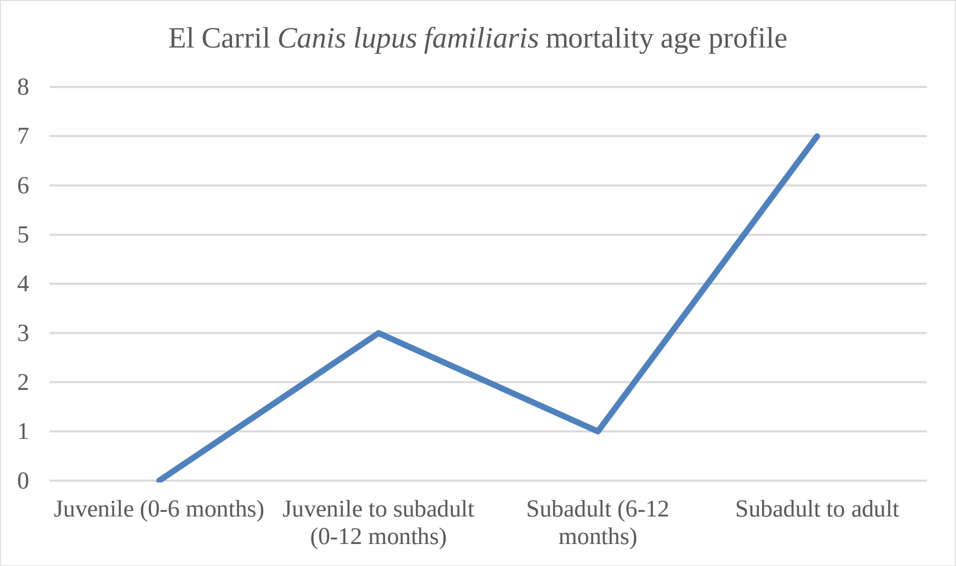


Figure 27: El Carril *Canis lupus familiaris* mortality age profile

6.1.2.3 Combined mortality age profiles for El Flaco and El Carril

In combining the two methods of mortality age determination a total of 28 individual specimens from both were applicable for age estimation (

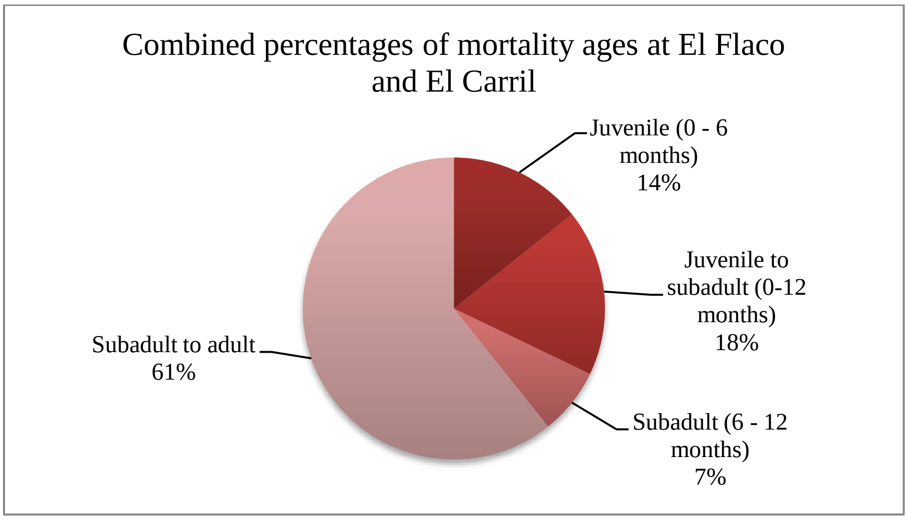


Figure 28: Combined percentages of mortality age ranges for *Canis lupus familiaris* remains

; Figure 29). The results demonstrate that 14.3% (n=4) of individuals were definitively juvenile animals that were younger than the age of full dental maturity at five months of age. In total, 39.3% (n=11) of all dogs were likely not adult and had not reached full developmental maturity. The remaining individuals (n=17) were either subadult or adult. These age estimations can only indicate the relative youngest age of complete epiphyseal fusion, so it is possible that many of the dogs that ranged over 5-11 months in age had reached developmental maturity.

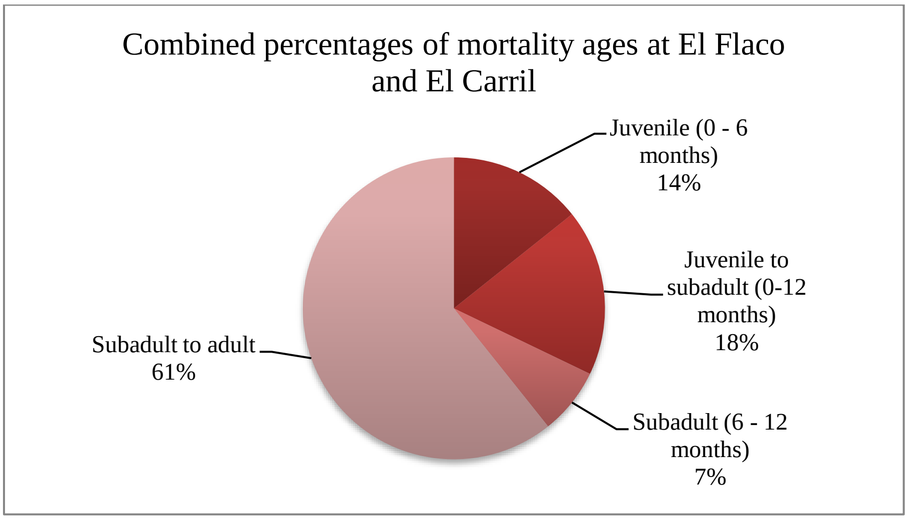


Figure 28: Combined percentages of mortality age ranges for *Canis lupus familiaris* remains

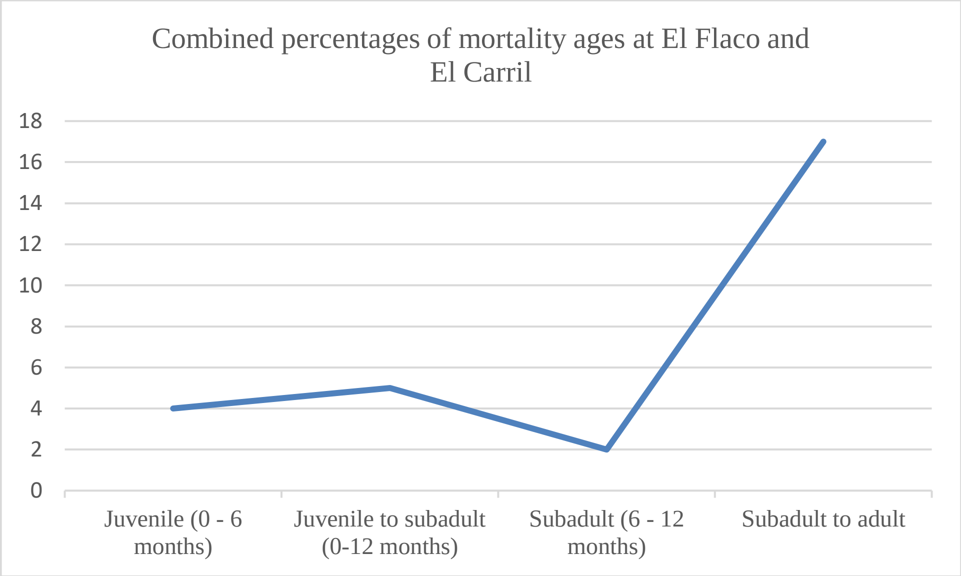


Figure 29: Combined El Flaco and El Carril mortality age profile

6.1.3 Reconstructions of morphology: body mass and shoulder height

6.1.3.1 Body mass (BM)

One left femur (El Flaco FND 2649) from a subadult individual was sufficiently intact to allow an accurate measurement of the midshaft circumference, which measured at 28.34 mm. The BM was calculated according to the formula outlined by Onar (*et al.* 2015):

BM of FND 2649 = 10 (2.88 x log (2.83)) - 3.4

FND 2649 = 9.61 kg

6.1.4.1 Shoulder height (SH)

As most elements from the El Carril assemblage are unsuitably fragmented, the only bones that were amenable for the calculation of SH belonged to the partial skeleton uncovered at El Carril (FND 396, 419, 424). The only intact elements belonging to this individual were the complete left tibia and a complete fifth metatarsal (FND 424).

The greatest length (GL) measurement of the left tibia was 158.68 mm, with the shortest distance in the mid-shaft shortest (SD) measured as 10.09 mm.

Therefore:

SH of FND 424 = (2.92 x 156.68 mm) + 9.41

FND 424 = 46.69 cm

From the same partial skeleton was found a complete fifth metatarsal (FND 424) allowing the GL of this elements to be measured at 56.46 mm.

The formula is as follows:

SH of FND 424= (0.83 x 56.46 mm) - 1.75 x 10

FND 424 = 45.11 cm

There is some slight disparity between the SH calculated from the osteometrics of the tibia (46.69 cm) and that calculated from the GL of the fifth metatarsal (45.11 cm). To account for this error the average of the two measurements was taken to represent the most probable SH estimating of this individual. Therefore, the SH of **FND 424 = 45.9 cm tall**.

One of the only elements from El Flaco that was sufficiently intact to allow for SH estimation was a fifth metacarpal uncovered (FND 2821) from Layer 1, Unit 69 at El Flaco. This element had a GL of 44.15 mm.

The formula is as follows:

SH of FND 2821 = (0.98 x 44.15 mm) - 1.56

FND 2821 = 41.7 cm

It was possible to calculate the SH of the upper skull (FND 2270) that was ritually interred at El Flaco by measuring the distance between two cranial parameters, the basion and the ethmoideum, which measured at 65.27 mm.

Therefore:

SH of FND 2270 = (1.016 x 65.27 mm - 31.2) x 10

FND 2270 = 35.11 cm

6.1.4.2 Sex determination

FND 2270, the complete cranial specimen was the only sample of the collection that had any potential for sex determination. The absence of a saggital crest indicates that this crania possibly belonged to a female (Shigehara *et al.* 1997). The absence from the assemblages of the only only concrete morphological criteria, the *baculum* bone, has rendered sex determination for the rest of the sample collection implausible.

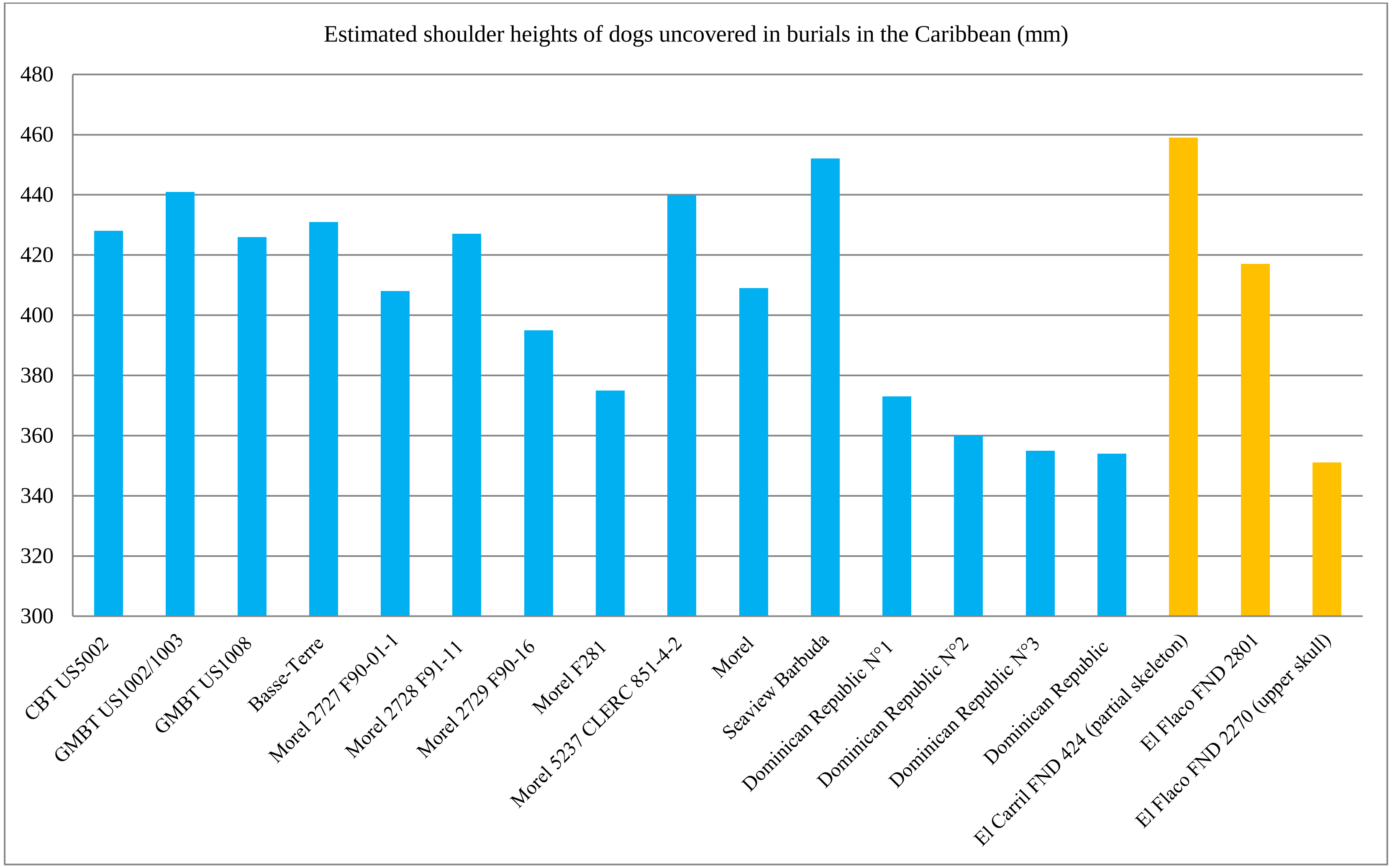


Figure 30: Estimated average shoulder heights in mm of dog burials from the French Antilles and the Dominican Republic (from Grouard *et al.* 2013); includes the three shoulder heights calculated from the assemblages of El Flaco and El Carril (in *yellow*). Note that the ritually interred individual is similar in stature to the other Dominican dog burials, whereas El Flaco FND 2821 and El Carril FND 424, the two non-burials represent notably taller animals

6.2 Results of the multi-isotopic analyses

6.2.1 Enamel isotope analysis results

In this section are detailed the stable isotope values of *C. familiaris* dental enamel from El Carril (n=7) and El Flaco (n=8), including the values of two extra *C. familiaris* teeth from the latter site that had previously been sampled by Dr. Jason Laffoon. To elicit interregional and inter-species comparisons of carbon ($\delta^{13}C$), oxygen ($\delta^{18}O$) and strontium ($^{87}Sr/^{86}Sr$) values, the results of samples previously analysed by Dr Jason E. Laffoon were included in the dataset. This extraneous data includes: pre-colonial *C. familiaris* enamel sample of a dog tooth pendant from Playa Grande, Dominican Republic (n=1); *C. familiaris* samples from Morel, Guadeloupe (n=7); *Homo sapiens* values from Morel in Guadeloupe (n=7), and from El Flaco (n=5), Atajadizo, (n=1), Juan Dolio (n=2), La Caleta (n=2) and Punta Macao (n=1) in the Dominican Republic.

Carbon ($\delta^{13}C_{en}$) and oxygen ($\delta^{18}O$) values serve as an indicator of certain plant types (C_3, C_4, CAM) and the sources of water that have been consumed by an organism respectively. Oxygen and strontium ($^{87}Sr/^{86}Sr$) values serve as an indication of the original locality of an organism. The following subsections contains tables detailing the maximum, minimum, range, mean and median of the enamel isotope values. Scatterplot diagrams have been included that detail the dietary and water intake ($\delta^{13}C$ / $\delta^{18}O$), and provenance ($\delta^{18}O$ / $^{87}Sr/^{86}Sr$) of humans and dogs from the Dominican Republic; and the diet and provenance ($\delta^{13}C$ / $^{87}Sr/^{86}Sr$) of humans and dogs from the Dominican Republic, and humans and dogs from Morel, Guadeloupe.

Table 11: Strontium, carbon and oxygen values obtained from enamel samples for all species and all sites. All samples that do not have a reference were analysed as part of this research. Source: [1] Dr Jason Laffoon, unpublished data; [2] Laffoon 2017; [3] Hofman *et al. in prep*

Island	**Site**	**FND**	**ID**	**Taxa**	**Element**	**Culture**	**87Sr/86Sr corrected**	**δ^{13}C VDPB**	**δ^{18}O VDPB**
Dom. Rep.	El Carril	FND 30	#4	*C. familiaris*	P2	pre-colonial	0.70903	-8.8	-1.8
Dom. Rep.	El Carril	FND 729	#15	*C. familiaris*	P2	pre-colonial	0.70764	-12.3	-4.7
Dom. Rep.	El Carril	FND 687	#25	*C. familiaris*	M2	pre-colonial	0.70761	-12.4	-5.3
Dom. Rep.	El Carril	FND 701	#35	*C. familiaris*	C1	pre-colonial	0.70762	-12.0	-4.8
Dom. Rep.	El Carril	FND 903	#36	*C. familiaris*	C1	pre-colonial	0.70759	-11.4	-3.5
Dom. Rep.	El Carril	FND 716	#41	*C. familiaris*	C1	pre-colonial	0.70806	-11.2	-3.4
Dom. Rep.	El Carril	FND 722	#43	*C. familiaris*	C1	pre-colonial	0.70807	-11.1	-3.8
Dom. Rep.	El Flaco	FND 1227 B	W341	*C. familiaris*	canine	—	0.70760	-11.8	-4.4
Dom. Rep.	El Flaco	FNR.2295	W777	*C. familiaris*	premolar	pre-colonial	0.70779	-11.1	-3.9
Dom. Rep.	El Flaco	FND 3269	#14	*C. familiaris*	dp4	pre-colonial	0.70786	-10.9	-2.1
Dom. Rep.	El Flaco	FND 3261	#19	*C. familiaris*	dp4	pre-colonial	0.70784	-11.3	-2.2
Dom. Rep.	El Flaco	FND 2828	#23.1	*C. familiaris*	I2	pre-colonial	0.70755	-10.4	-3.6
Dom. Rep.	El Flaco	FND 2838	#40	*C. familiaris*	P2	pre-colonial	0.70828	-11.6	-2.7
Dom. Rep.	El Flaco	FND 2812	#42	*C. familiaris*	P1	pre-colonial	0.70812	-10.9	-4.4
Dom. Rep.	El Flaco	FND 2270	#29.1	*C. familiaris*	C1	pre-colonial	0.70816	-10.7	-3.9
[1] Guadeloupe	Morel	255	—	*C. familiaris*	P	pre-colonial	0.70914	—	—
[1] Guadeloupe	Morel	262*	—	*C. familiaris*	P	pre-colonial	0.70802	-11.1	—
[1] Guadeloupe	Morel	263*	—	*C. familiaris*	unid.	pre-colonial	0.70798	—	—
[1] Guadeloupe	Morel	706,1	—	*C. familiaris*	unid.	pre-colonial	0.70902	-12.7	—
[1] Guadeloupe	Morel	706,3	—	*C. familiaris*	M	pre-colonial	0.70914	-11.1	—
[1] Guadeloupe	Morel	1969A	—	*C. familiaris*	unid.	pre-colonial	0.70913	—	—
[1] Guadeloupe	Morel	1969B	—	*C. familiaris*	M	pre-colonial	0.70913	—	—
[2] Dom. Rep.	Playa Grande	Corte7(A-H) UE1-2	T886	*C. familiaris*	canine	pre-colonial	0.70839	-11.1	-4.2
[2] Dom. Rep.	Atajadizo	M-6 Ent.2	T887	*H. sapiens*	molar	Ostionoid	0.70909	-12.1	-2.9
[3] Dom. Rep.	El Flaco	FNR.1216	W773	*H. sapiens*	molar	pre-colonial	0.70692	-12.2	-5.0
[3] Dom. Rep.	El Flaco	FNR.1894	W774	*H. sapiens*	premolar	pre-colonial	0.70711	-12.1	-4.5
[3] Dom. Rep.	El Flaco	FNR.2382	W775	*H. sapiens*	incisor	pre-colonial	0.70829	-12.1	-3.9
[3] Dom. Rep.	El Flaco	FNR.2365	W776	*H. sapiens*	premolar	pre-colonial	0.70786	-11.6	-4.4
[3] Dom. Rep.	El Flaco	FNR.1216	W336	*H. sapiens*	dec. molar	pre-colonial	0.70705	-12.6	-4.2
[2] Dom. Rep.	El Soco	26A	T891	*H. sapiens*	molar	Ostionoid	0.70909	-12.6	-4.4
[2] Dom. Rep.	Juan Dolio	DR-JD10	U519	*H. sapiens*	incisor	Ostionoid	0.70915	-12.0	-3.4
[2] Dom. Rep.	Juan Dolio	DR-JD22A	U520	*H. sapiens*	incisor	Ostionoid	0.70911	-12.1	-3.3
[2] Dom. Rep.	La Caleta	30A	T888	*H. sapiens*	premolar	Ostionoid	0.70916	-12.5	-3.8
[2] Dom. Rep.	La Caleta	20A	T889	*H. sapiens*	molar	Ostionoid	0.70917	-12.5	-4.3
[1] Guadeloupe	Morel	80,2	—	*H. sapiens*	M1	pre-colonial	0.70905	-12.6	—

Island	**Site**	**FND**	**ID**	**Taxa**	**Element**	**Culture**	**87Sr/86Sr corrected**	**δ^{13}C VDPB**	**δ^{18}O VDPB**
[1] Guadeloupe	Morel	F338	—	*H. sapiens*	P1	pre-colonial	0.70910	-11.5	—
[1] Guadeloupe	Morel	F90.07	—	*H. sapiens*	C	pre-colonial	0.70903	-12.1	—
[1] Guadeloupe	Morel	F90.12*	—	*H. sapiens*	C	pre-colonial	0.70864	-12.9	—
[1] Guadeloupe	Morel	F91.01*	—	*H. sapiens*	P1	pre-colonial	0.70881	-11.9	—
[1] Guadeloupe	Morel	F91.08*	—	*H. sapiens*	M1	pre-colonial	0.70710	-11.7	—
[1] Guadeloupe	Morel	F91.10*	—	*H. sapiens*	M1	pre-colonial	0.70857	-11.3	—
[2] Dom. Rep.	Punta Macao	#25	T890	*H. sapiens*	molar	Ostionoid	0.70905	-12.0	-4.8
[2] Dom. Rep.	El Flaco	FNR.1213	W337	*I. portoricensis*	incisor	—	0.70797	-13.0	-5.0
[2] Dom. Rep.	El Flaco	FNR.1227. A1	W338	*I. portoricensis*	incisor	—	0.70620	-11.0	-4.4
[2] Dom. Rep.	El Flaco	FNR.1227. A2	W339	*I. portoricensis*	incisor	—	0.70745	-11.7	-4.6
[2] Dom. Rep.	El Flaco	FNR.1227. A3	W340	*I. portoricensis*	incisor	—	0.70729	-13.1	-5.1

6.2.2 Enamel value statistical summaries and scatter plot diagrams

Table 12: Statistical summaries of strontium and carbon values from enamel samples

	All data		**All dogs**		**All humans**		**D.R. Humans and dogs**		**D.R. Humans**		**D.R. dogs**	
	^{87}Sr/^{86}Sr corrected	**∂^{13}C (‰)**	**^{87}Sr/^{86}Sr corrected**	**∂^{13}C (‰)**	**^{87}Sr/^{86}Sr corrected**	**∂^{13}C (‰)**	**^{87}Sr/86Sr corrected**	**∂^{13}C (‰)**	**^{87}Sr/^{86}Sr corrected**	**∂^{13}C (‰)**	**^{87}Sr/^{86}Sr corrected**	**∂^{13}C (‰)**
MEAN	0.7082	-11.7	0.7082	-11.3	0.7085	-12.1	0.708152	-11.6	0.7084	-12.2	0.7080	-11.2
MEDIAN	0.7081	-11.9	0.7081	-11.1	0.7090	-12.1	0.708064	-11.9	0.7091	-12.1	0.7078	-11.2
MIN	0.7062	-13.1	0.7075	-12.7	0.7069	-12.9	0.706924	-12.6	0.7069	-12.6	0.7075	-12.4
MAX	0.7092	-8.8	0.7091	-8.8	0.7092	-11.3	0.709174	-8.8	0.7092	-11.6	0.7090	-8.8

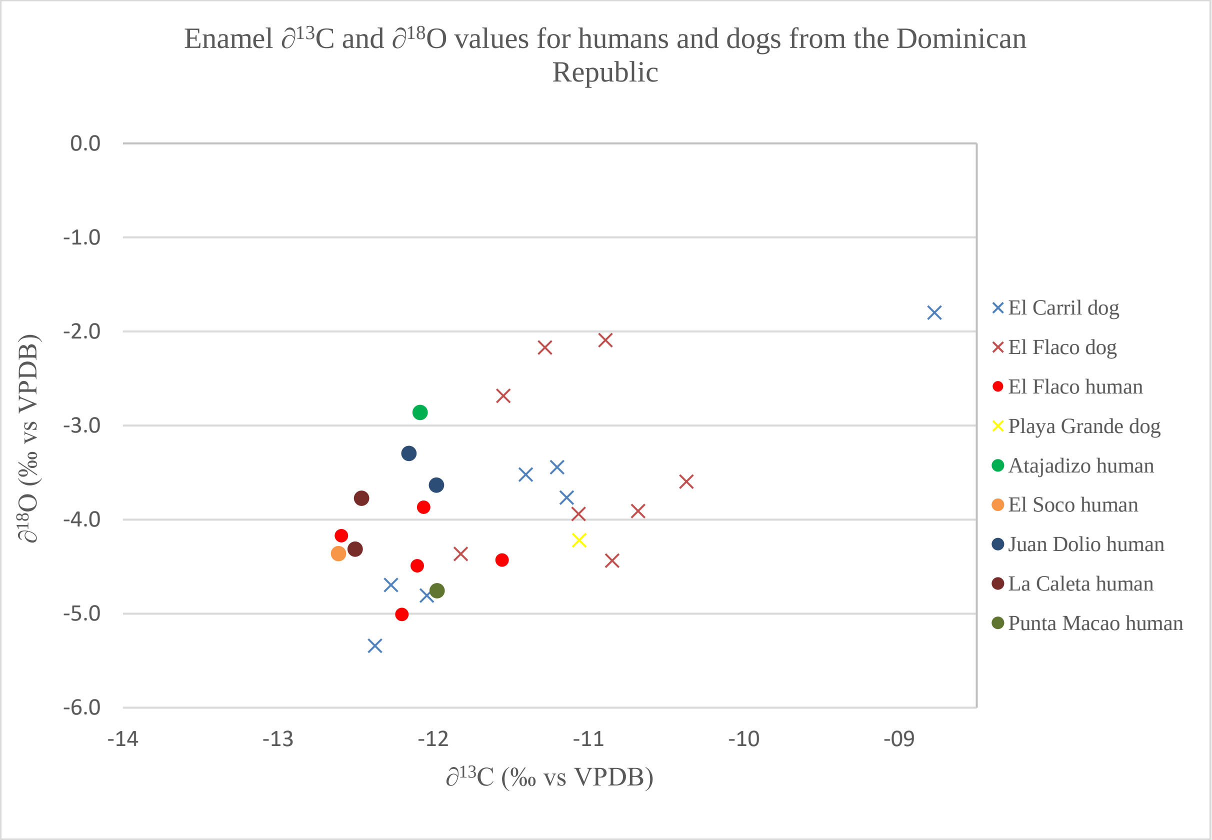


Figure 31: Carbon (δ^{13}C) and oxygen (δ^{18}O) values for human and dog enamel samples obtained from pre-colonial archaeological sites in the Dominican Republic

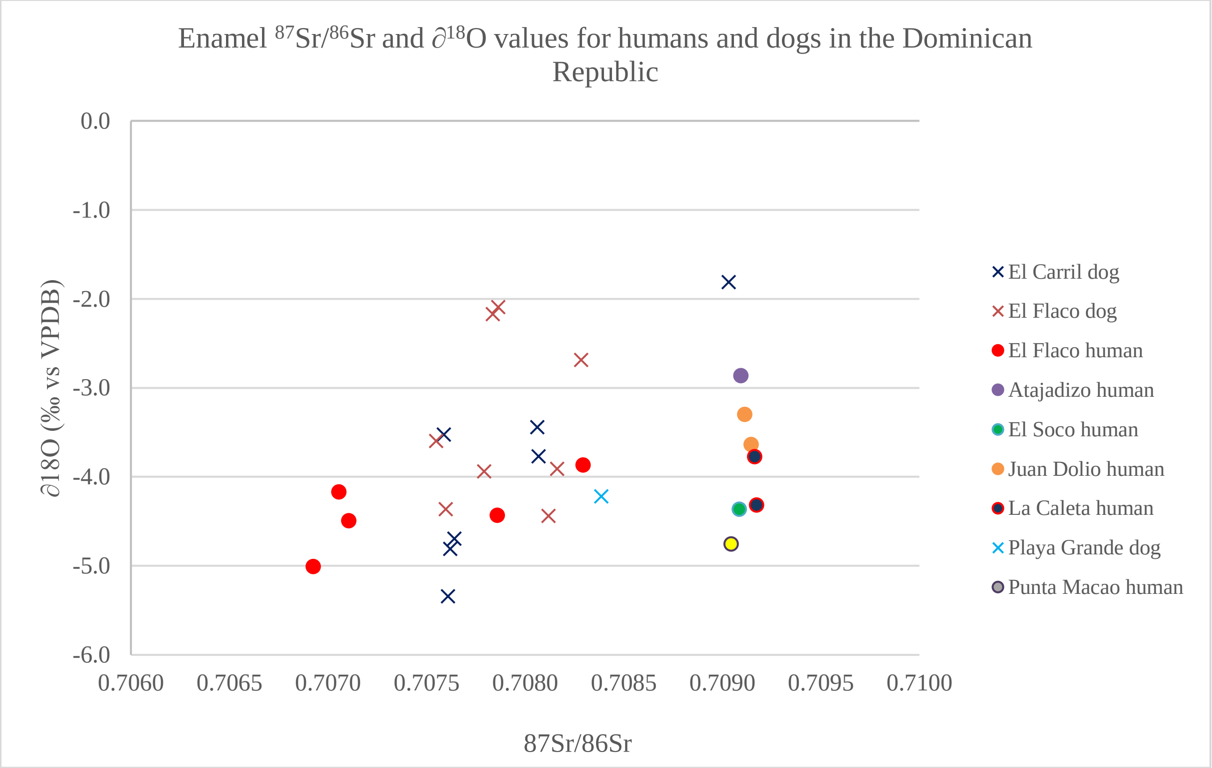


Figure 32: Strontium ($^{87}Sr/^{86}Sr$) and oxygen ($\delta^{18}O$) values for human and dog enamel samples obtained from pre-colonial archaeological sites in the Dominican Republic

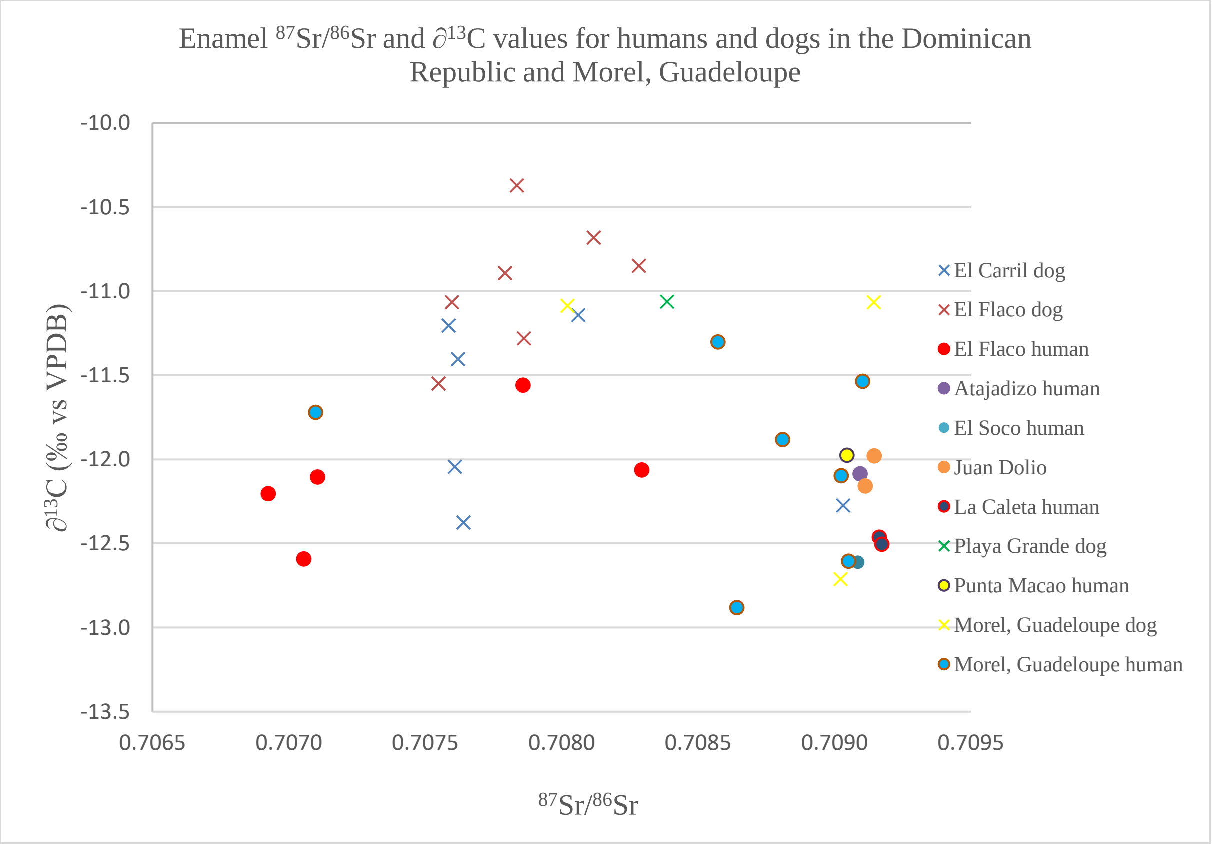


Figure 33: Strontium ($^{87}Sr/^{86}Sr$) and carbon ($\delta^{13}C$) values for human and dog enamel samples obtained from pre-colonial archaeological sites in the Dominican Republic

6.2.3 Collagen stable isotope analysis results

This sub-section contains the carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) values obtained from the collagen samples of the *C. familiaris* remains uncovered at El Flaco (n=10) and El Carril (n=5). To establish interregional comparisons of dietary intake additional skeletal samples of *C. familiaris* from three archaeological sites in the Lesser Antilles were analysed, these have been added to the dataset. These samples include *C. familiaris* collagen samples from Cathédrale de Basse-Terre (n=2) and Morel (n=6) in Guadeloupe, and Hope Estate (n=1) in Saint-Martin, and one dog sample from Punta Candelero, Puerto Rico that was analysed as part of a study by Dr William Pestle (Pestle 2010, 429).

To aid in assessing the validity of the canine surrogacy approach for the insular Caribbean, several previously recorded *Homo sapiens* collagen samples were included. These samples include human bone from El Flaco (n=15) (Hofman *et al., in prep.*) and from the eastern coastal site of El Cabo (n=3) in the Dominican Republic (Laffoon 2017). There is currently no human collagen data available from the site of El Carril.

Five collagen samples did not produce enough collagen during the extraction process (El Flaco FND 731, 2610, 2838; El Carril FND 716; Morel 2732). Additionally, one sample reliquefied after the lyophilisation process (HE 2302B). There was not enough spare bone for repeat sampling of these failed samples. Of the 24 collagen samples that were successfully extracted as part of this research, three samples (HE 3305B; Morel 2734; Morel 2728) exhibited inadequate atomic C:N values as outlined by Ambrose (1990), falling outside the accepted quality range of collagen preservation (C:N 2.9-3.6). Additionally, sample HE 2503C did not produce any data during spectrometry likely due to poor collagen preservation. The total amount of failed collagen samples was 11, whilst 21 samples yielded good quality data.

Carbon ($\delta^{13}C_{co}$) and nitrogen ($\delta^{15}N$) values obtained from collagen provide information pertaining to the types of food that were consumed and provide information as to the trophic level of consumed foods. The following subsection contains a table detailing the maximum, minimum, range, mean and median of the collagen isotope values. A scatterplot diagram was generated that details the dietary intake ($\delta^{13}C$ / $\delta^{15}N$) of *C. familiaris* and *H. sapiens* recovered from sites in the Dominican Republic; and additionally of *C. familiaris* carbon and nitrogen values from the Dominican Republic and from the three Lesser Antillean sites. An additional scatterplot is included which divides up humans and dogs according to whether samples were uncovered from multifunctional mounds or burial contexts.

Table 13: Carbon and nitrogen values obtained from collagen samples of all species and all sites. All samples that do not have a reference listed were sourced and analysed by the author as part of this research. References with dates are sourced from published materials. Sources: [1] Pestle 2010; [2] Hofman *et al., in prep*

Region	**Site**	**FND**	**ID**	**Taxa**	**Element**	**∂^{15}N (‰ vs N$_{air}$)**	**∂^{13}C (‰ vs VPDB)**	**wt%C**	**wt%N**	**Atomic C:N ratio**
Guadeloupe	Cathedral Basse-Terre	3008	CBT 3008	*Canis lupus familiaris*	rib	9.4	-18.7	37.84	13.46	3.28
Guadeloupe	Cathedral Basse-Terre	5002	CBT 5002	*Canis lupus familiaris*	vertebra	9.6	-18.4	10.58	3.90	3.17
Dom. Rep.	El Carril	FND 424	#6.26	*Canis lupus familiaris*	metapodial	11.0	-18.3	40.09	14.41	3.25
Dom. Rep.	El Carril	FND 729	#15	*Canis lupus familiaris*	mandible	11.4	-18.1	37.26	13.56	3.21
Dom. Rep.	El Flaco	FND 3491	#16	*Canis lupus familiaris*	mandible	12.7	-18.7	42.27	14.85	3.32
Dom. Rep.	El Carril	FND 771	#31	*Canis lupus familiaris*	maxilla	9.0	-18.0	40.80	14.54	3.27
Dom. Rep.	El Carril	FND 722	#33	*Canis lupus familiaris*	ulna	8.3	-18.8	34.27	12.19	3.28
Dom. Rep.	El Flaco	FND 3170	#8	*Canis lupus familiaris*	vertebra	8.9	-18.6	44.36	15.65	3.31
Dom. Rep.	El Flaco	FND 2801	#10	*Canis lupus familiaris*	metacarpal	8.7	-18.5	41.47	14.48	3.34
Dom. Rep.	El Flaco	FND 2821	#11	*Canis lupus familiaris*	metacarpal	8.4	-18.4	44.91	16.29	3.22
Dom. Rep.	El Flaco	FND 3261	#19	*Canis lupus familiaris*	mandible	13.1	-18.7	43.67	15.49	3.29
Dom. Rep.	El Flaco	—	#21	*Canis lupus familiaris*	ulna	8.2	-16.5	38.69	14.11	3.20
Dom. Rep.	El Flaco	FND 2828	#23	*Canis lupus familiaris*	maxilla	9.9	-19.5	29.72	10.44	3.32
Dom. Rep.	El Flaco	FND 3050	#27	*Canis lupus familiaris*	vertebra	11.2	-16.9	32.56	11.41	3.33
Dom. Rep.	El Flaco	FND 2270	#29	*Canis lupus familiaris*	cranial	10.8	-18.5	38.71	14.23	3.18
Dom. Rep.	El Flaco	FND 2649	#32	*Canis lupus familiaris*	femur	8.2	-16.5	37.60	13.62	3.22
Dom. Rep.	El Flaco	FND 2812	#44	*Canis lupus familiaris*	radius	9.7	-18.5	21.01	7.56	3.25
[1] Puerto Rico	Punta Candelero	C17	—	*Canis lupus familiaris*	—	8.6	-17.8	22.78	8.07	3.31
St Martin	Hope Estate	2009E	HE2009E	*Canis lupus familiaris*	long bone	12.7	-15.6	44.47	16.05	3.23
Guadeloupe	Morel	2727	Morel 2727	*Canis lupus familiaris*	rib	9.2	-19.7	42.09	15.39	3.19
Guadeloupe	Morel	2729	Morel 2729	*Canis lupus familiaris*	rib	9.2	-18.6	41.19	14.39	3.34
Guadeloupe	Morel	2730	Morel 2730	*Canis lupus familiaris*	rib	10.4	-19.4	32.14	11.03	3.40
Guadeloupe	Morel	2731	Morel 2731	*Canis lupus familiaris*	rib	9.5	-17.8	39.24	13.97	3.28
Guadeloupe	Morel	5237	Morel 5237	*Canis lupus familiaris*	rib	10.5	-19.4	37.94	13.37	3.31
Guadeloupe	Morel	2675	—	*Canis lupus familiaris*	rib	8.8	-17.8	35.86	12.66	3.31
Dom. Rep.	El Carril	FND 11	#1	*Cyclura sp.*	vertebra	7.1	-21.1	40.01	14.04	3.33
Dom. Rep.	El Carril	FND 952	#5	*Cyclura sp.*	dentary	9.0	-20.8	43.32	15.51	3.26
Dom. Rep.	El Carril	FND 953	#6	*Cyclura sp.*	dentary	11.3	-20.9	46.02	16.74	3.21
Dom. Rep.	El Carril	FND 996	#7	*Cyclura sp.*	vertebra	8.2	-20.4	43.94	15.47	3.32
Dom. Rep.	El Carril	FND 1284	#14	*Cyclura sp.*	maxilla	14.3	-20.6	42.77	15.24	3.28
Dom. Rep.	El Carril	FND 1400	#17	*Cyclura sp.*	dentary	7.4	-21.3	35.39	12.34	3.35
Dom. Rep.	El Carril	FND 1498	#18	*Cyclura sp.*	mandible	7.1	-21.3	31.14	11.25	3.23
[2] Dom. Rep.	El Cabo	—	F84-29-186	*Homo sapiens*	—	9.7	-18.5	39.24	14.30	3.20
[2] Dom. Rep.	El Cabo	—	F85-34-06	*Homo sapiens*	—	11.2	-18.6	37.14	13.72	3.16

Region	Site	FND	ID	Taxa	Element	∂^{15}N (‰ vs N $_{air}$)	∂^{13}C (‰ vs VPDB)	wt%C	wt%N	Atomic C:N ratio
[2] Dom. Rep.	El Cabo	—	F85-40-17	*Homo sapiens*	—	9.9	-18.4	42.09	15.36	3.20
[2] Dom. Rep.	El Flaco	F45-15	—	*Homo sapiens*	rib	10.9	-18.4	41.59	15.00	3.24
[2] Dom. Rep.	El Flaco	F45-18	—	*Homo sapiens*	rib	10.2	-18.2	40.70	14.63	3.25
[2] Dom. Rep.	El Flaco	F45-22	—	*Homo sapiens*	rib	9.8	-17.3	43.14	15.26	3.30
[2] Dom. Rep.	El Flaco	F47-223	—	*Homo sapiens*	rib	10.9	-18.3	41.12	14.63	3.28
[2] Dom. Rep.	El Flaco	F56-19	—	*Homo sapiens*	rib	10.0	-18.9	42.03	15.05	3.26
[2] Dom. Rep.	El Flaco	F67-08	—	*Homo sapiens*	rib	11.9	-18.5	42.00	15.18	3.23
[2] Dom. Rep.	El Flaco	F45-20	—	*Homo sapiens*	—	8.8	-18.5	42.73	15.54	3.21
[2] Dom. Rep.	El Flaco	F45-27	—	*Homo sapiens*	—	9.6	-18.1	43.07	15.66	3.21
[2] Dom. Rep.	El Flaco	F44-04	—	*Homo sapiens*	—	10.5	-18.1	41.50	15.05	3.22
[2] Dom. Rep.	El Flaco	F54-66	—	*Homo sapiens*	—	9.2	-17.9	42.34	15.75	3.14
[2] Dom. Rep.	El Flaco	F55-141	—	*Homo sapiens*	—	9.9	-19.1	41.62	15.33	3.17
[2] Dom. Rep.	El Flaco	F45-31	—	*Homo sapiens*	—	9.9	-19.0	42.76	15.94	3.13
[2] Dom. Rep..	El Flaco	F55-128	—	*Homo sapiens*	—	9.3	-18.9	42.70	15.83	3.15
[2] Dom. Rep.	El Flaco	F45-29	—	*Homo sapiens*	—	10.7	-19.0	41.36	15.42	3.13
[2] Dom. Rep..	El Flaco	F63-73-38	—	*Homo sapiens*	—	10.4	-18.6	44.36	16.36	3.16
Dom. Rep.	El Carril	FND 855	#2	*Isolobodon portoricensis*	mandible	1.8	-19.4	43.36	15.61	3.24
Dom. Rep.	El Carril	FND 855	#3	*Isolobodon portoricensis*	mandible	4.4	-20.1	43.15	15.66	3.22
Dom. Rep.	El Carril	FND 855	#4	*Isolobodon portoricensis*	tibia	2.0	-20.7	44.82	15.96	3.28
Dom. Rep.	El Carril	FND 1088	#8	*Isolobodon portoricensis*	mandible	5.6	-20.6	42.34	14.99	3.30
Dom. Rep.	El Carril	FND 1088	#9	*Isolobodon portoricensis*	mandible	5.8	-16.3	43.26	15.28	3.30
Dom. Rep.	El Carril	FND 1169	#10	*Isolobodon portoricensis*	femur	4.5	-19.7	44.72	16.05	3.25
Dom. Rep.	El Carril	FND 1169	#11	*Isolobodon portoricensis*	mandible	4.2	-19.7	45.48	16.45	3.23
Dom. Rep.	El Carril	FND 1270	#12	*Isolobodon portoricensis*	tibia	2.3	-20.9	43.90	16.01	3.20
Dom. Rep.	El Carril	FND 1270	#13	*Isolobodon portoricensis*	femur	4.4	-20.6	39.58	14.40	3.21
Dom. Rep.	El Carril	FND 1286	#15	*Isolobodon portoricensis*	mandible	10.0	-18.0	46.22	16.80	3.21
Dom. Rep.	El Carril	FND 1286	#16	*Isolobodon portoricensis*	mandible	2.4	-20.7	44.60	16.04	3.25
Dom. Rep.	El Carril	FND 1027	#19	*Isolobodon portoricensis*	mandible	5.6	-19.5	43.11	15.30	3.29

6.2.4 Collagen value statistical summaries and pivot tables

Table 14: Statistical summaries of carbon and nitrogen values from *Canis lupus familiaris, Homo sapiens, Isolobodon portoricensis* and *Cyclura* sp. collagen samples from the Dominican Republic, Guadeloupe and Saint -Martin; summaries of human and dog carbon and nitrogen values from the Dominican Republic

	All samples		**All dogs**		**D.R. Humans**		**D.R. dogs**		**D.R. humans/dogs**	
	∂^{15}N (‰)	**∂^{13}C (‰)**	**∂^{15}N (‰)**	**∂^{13}C (‰)**	**∂^{15}N (‰)**	**∂^{13}C (‰)**	**∂^{15}N (‰)**	**∂^{13}C (‰)**	**∂^{15}N (‰)**	**∂^{13}C (‰)**
MEAN	8.8	-18.9	9.9	-18.2	10.1	-18.5	10.0	-18.2	10.1	-18.3
MEDIAN	9.4	-18.6	9.5	-18.5	10.0	-18.5	9.7	-18.5	9.9	-18.5
MIN	1.8	-21.3	8.2	-19.7	8.8	-19.1	8.2	-19.5	8.2	-19.5
MAX	14.3	-15.6	13.1	-15.6	11.9	-17.3	13.1	-16.5	13.1	-16.5
RANGE	12.5	5.7	4.9	4.1	3.1	1.8	4.9	3.0	4.9	3.0

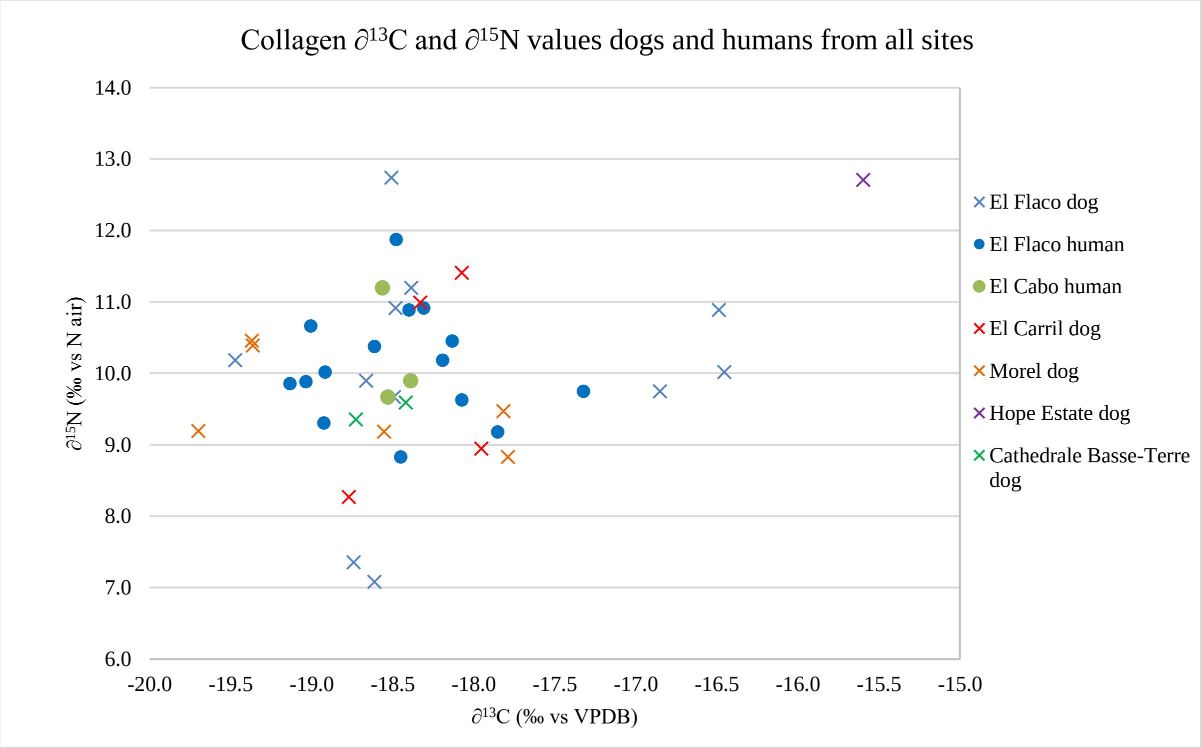


Figure 34: Carbon and nitrogen values from collagen samples of dogs and humans from the Dominican Republic (El Flaco, El Cabo, El Carril); and dogs from Guadeloupe (Cathédrale de Basse-Terre, Morel) and Saint-Martin (Hope Estate)

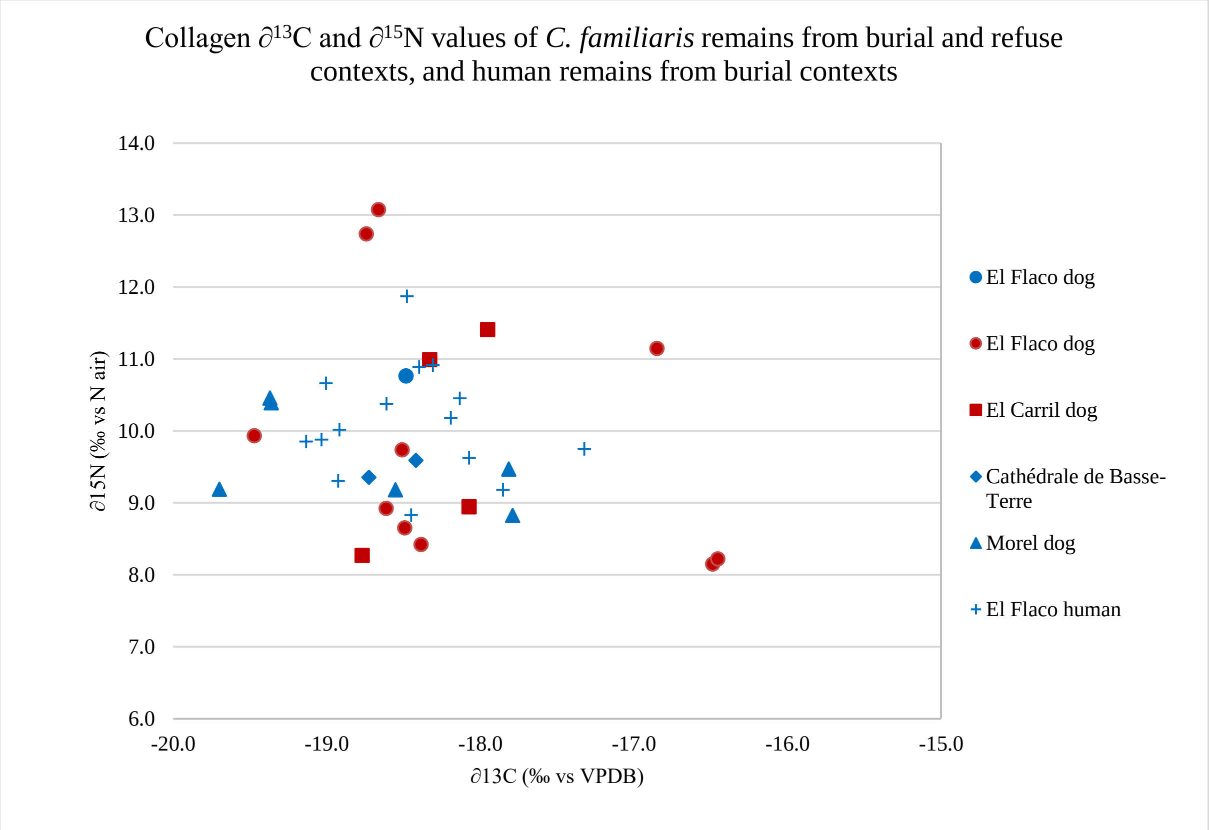


Figure 35: Collagen isotope values of dogs from all sites: El Flaco and El Carril, Dominican Republic; Cathédrale de Basse-Terre and Morel, Guadeloupe. Human and dog remains uncovered from burial contexts are in *blue*; dog remains uncovered from non-burial contexts are in *red*.

Table 15: Mean collagen values from humans that were previously recorded data throughout the insular Caribbean, and collagen data from dogs and humans from this research. Data generated in this research is labelled in *bold* (after Laffoon *et al.* 2016)

Island	**Site**	**Species**	**$\delta^{13}C_{co}$ mean**	**$\delta^{13}N$ mean**	**Reference**
Bahamas	Multiple	Human	-13.4	9.8	Stokes 1998
Haiti	Manigat Cave	Human	-16.5	8.7	Stokes 1998
Dom. Rep.	Juan Dolio	Human	-17.1	11.9	Stokes 1998
Dom. Rep.	Boca del Soco	Human	-18.0	11.9	Stokes 1998
Dom. Rep	El Flaco	Human	-18.5	10.1	Hofman *et al. in prep*
Dom. Rep	**El Flaco**	**Dog**	**-18.2**	**10.0**	
Dom. Rep.	**El Carril**	**Dog**	**-18.3**	**9.9**	
Dom. Rep.	El Cabo	Human	-18.5	10.3	Laffoon 2017
Puerto Rico	Maisabel	Human	-18.1	9.7	Pestle 2010
Puerto Rico	Paso del Indio	Human	-19.1	9.8	Pestle 2010
Puerto Rico	Punta Candelero	Human	-17.5	9.9	Pestle 2010
Puerto Rico	Tibes	Human	-17.6	9.5	Pestle 2010
Puerto Rico	Rio Tanamá	Human	-19.6	9.1	Antón 2008
St. Thomas	Tutu	Human	-15.5	12.2	Norr 2002
Anguilla	Multiple	Human	-14.4	10.1	Stokes 1998
St. Martin	Hope Estate	Human	-15.7	10.4	Stokes 1998
St. Martin	**Hope Estate**	**Dog**	**-15.6**	**12.7**	
Saba	Multiple	Human	-15.7	10.8	Stokes 1998
St. Kitts	Bloody Point	Human	-15.3	11.0	Farr 1996
Grande-Terre, Guadeloupe	Anse a la Gourde	Human	-14.8	10.9	Stokes 1998; Laffoon and de Vos 2011
Grande-Terre, Guadeloupe	**Morel**	**Dog**	**-18.8**	**9.6**	
Basse-Terre	**Cathédrale Basse-Terre**	**Dog**	**-18.6**	**9.5**	
La Desirade	Petite Riviere	Human	-14.1	10.3	Stokes 1998
St. Lucia	Grande Anse	Human	-16.3	12.4	Stokes 1998
St. Lucia	Lavoutte	Human	-16.0	11.6	Laffoon *et al.* 2016
Carriacou	Grand Bay	Human	12.8	11.1	Krigbaum *et al.* 2013
Grenada	Pearls	Human	-17.0	12.6	Stokes 1998

Chapter Seven: Discussion

7.1 Depositional context of *C. familiaris* remains at El Flaco and El Carril

The presence of isolated elements in the multifunctional mounds at both sites suggests that most dog remains were subject to similar depositional or post-depositional processes as the other cultural and biological material. There is the possibility that taphonomic processes such as fluvial action, bioturbation and soil acidity may have affected bone degradation or the redistribution of individual elements away from their primary depositional contexts. Moreover, due to the multifunctionality of the mounds observed at both El Flaco and El Carril, this scattered arrangement of material cannot necessarily be accounted for by the intentional sweeping or cleaning of habitation and refuse areas by the indigenous inhabitants of both sites. The reasons behind this seemingly random deposition of both highly fragmented dog and human remains within these mounds are currently unknown. However, fragmented dog remains may represent ceremonial feasting activities, this notion is supported by the high quantities of juvenile and subadult *C. familiaris* remains that were uncovered from both sites. Another interpretation to explain the presence of fragmented human and canine bones within these multifunctional mounds is that this was an intentional practice, constituting some form of ancestor veneration by physically situating the dead within domestic space. These multifunctional mounds could therefore constitute palimpsests reflective of the whole gamut of Amerindians lifeways, including aspects of Amerindian cosmovision.

The high quantity of dispersed individual dog specimens within non-burial contexts at El Flaco and El Carril suggests that dog inhumations in Late Ceramic Age Hispaniola were not as common as what has been observed elsewhere throughout the insular Caribbean (Newsom and Wing 2004; Wing 1972; 1991; 2001). According to Grouard and colleagues (2013), the practice of burying dogs diminished considerably throughout the insular Caribbean after the Early Ceramic Age. It is likely that this pattern was repeated in Hispaniola, and the majority of skeletal remains from El Flaco and El Carril belonged to dogs that were not buried. At El Flaco, there is only one instance of intentional inhumation, that being the interred remains of a dog upper skull and both innominates (FND 2270, Feature 45-10), found in a depositional relationship with 16 human burials. The inhumation of complete skeletons is the more common occurrence throughout the Caribbean, so the burial of dismembered dog remains in association with human burials is unusual and may in turn represent a secondary burial. However, the purposeful deposition of dismembered canid remains associated with human burials is seen at Silver Sands in Barbados, dating to 1000 ± 150 to 650 ± 100 BP, from which a complete dog burial was also recovered (Drewett 1991; 2000; 2004; Wing 2008). The implications of this inhumation at El Flaco, and that from the previously excavated dog burial from El Carril, and what they indicate about the cosmological positioning of dogs for the indigenous peoples of Hispaniola.

7.2 Evidence of butchery and cynophagy

The only two elements that possibly exhibit anthropogenic bone surface modification are from the same disarticulated partial skeleton excavated at El Carril. These markings are present on the same elements; the left and right tibia and are situated towards the proximal and distal ends on the diaphyses. Midshaft cuts on long bones such as femurs, humeri and tibia are a possible indication of the filleting of meat from high-yield areas (Bunn 1983; Marshall 1986a). However, as it is taken that dog tibiae are likely not high-yield areas and given the perpendicular nature of these markings to the natural axis of the bone, these markings may be the remnant of skinning activities. Upon magnification however, no clear indication of butchery by lithic tools could be deduced. Although, given the scattered deposition of these remains and the fact that none of the cranial or axial elements were present in the assemblage, it is feasible that butchery had occurred on this animal and the other elements had been disposed of elsewhere.

The largely unarticulated nature of this skeleton—scattered over 3m^2 and 0.2m of depth—is suggestive that this was not an inhumation, although it is possible that taphonomic processes may be responsible for the dissemination of the remains. None of the axial and cranial regions were represented in this individual. Fragmented bone was also found in same context as this individual, however as to what element these bones belonged was indeterminate due to poor preservation and their highly fragmented nature. In Binford’s (1981, 91) summation of the butchery practices of four African hunter-gatherer groups (Gifford 1997), and two Amerindian groups—the Navajo and Nunamiut Eskimos (Binford 1978; Binford and Betram 1977)—it was noted that it is common for axial elements, such as vertebrae and spine, to be separated and subject to different treatment compared to the rest of the body. According to Binford, the front and hind limbs are commonly disarticulated from the main body axis during butchery. The intentional dismemberment of this individual, resulting in a relatively closely-spaced depositional distribution of largely only appendicular elements is therefore a possibility. Although the markings exhibited on the two tibiae cannot be safely attributed to a lithic tool, the spatial distribution of the remains, the absence of axial and cranial elements, and the presence of linear, parallel markings on both tibia indicates that this individual was likely butchered.

These linear markings exhibited on the tibiae and the absence of axial and cranial elements from the partial skeleton uncovered at El Carril, coupled with the scattered deposition and highly fractured nature of individual *C. familiaris* elements at both sites, is indicative that dogs were possibly being butchered possibly for the purposes of cynophagy—the practice of eating dogs—during the Late

Ceramic Age in the Dominican Republic. Cynophagy is well recorded in early ethnohistorical accounts, as exemplified in the accounts of Bartolomé de las Casas (Las 1909, 26, Capítulo 10), Peter Martyr d'Angheira (Mártir de Anglería 1892, 189, Capítulo 5) and Spanish clergyman Andrés Bernáldez (1856, 315, Capítulo 127). However, this conclusion is merely speculative, particularly since there is an absence of macroscopic evidence that would suggest more securely the butchery or importantly the cooking of any canid elements.

7.3 Interpretation of mortality profiles

The mortality profile of *C. familiaris* investigated from both sites is attritional in nature, with a high prevalence of juvenile individuals. Most dogs were either subadult or of possible breeding age, as sexual maturity occurs in dogs at between 6-14 months of age dependent on the breed and size of the animal (Concannon 2011). An attritional mortality profile is also possibly indicative of the adverse effects of malnutrition, congenital defects, or disease that has affected high mortality of young individuals. A carnivorous husbandry model—the intentional targeting of younger animals when the production of meat is of primary concern—cannot be ruled out given the high rates of mortality of non-breeding age juvenile animals. However, the evidence to suggest as such is not convincing, as carnivorous husbandry practices are usually associated with animals that are difficult or expensive to maintain solely for the purposes of obtaining meat, such as Eurasian cattle (Levine 1983, 29), whereas dogs are notoriously inexpensive animals and require little maintenance and care to ensure their survival.

The relatively high component of juvenile dogs (n=4, 14.29%) is possibly suggestive of an intentional targeting of younger animals, however distinguishing this from natural rates of attrition is problematic. In total, 21.42% of all dogs from both sites were under the age of full maturity at 12 months. Without further evidence that would suggest intentional butchery on these specific elements these immature animals may have died due to natural causes. However, there is the real possibility that these animals may have been consumed as part of ritual feasting activity. As has been observed archaeologically in sites throughout Mesoamerica, a predominance of juvenile aged dogs associated with ritual feasting events is seen at Postclassic Mayan Chaac Mool (Blanco Padilla *et al.* 1999), whilst feasting associated with religious events and festivals has been determined to have been a common occurrence during the pre-colonial period throughout most of Mexico (Valadez Azúa 2003).

The lesser amount of definitively determined subadult individuals (n=2) and increasing mortality rate of subadult to adult individuals (at least over 6 months of age) is suggestive that these animals were permitted to reach breeding age before their deaths. However, of importance is that the partial skeleton was a subadult, aged at 6-7 months of age, indicating that this animal was targeted perhaps at the onset of sexual maturity. Further clarity in interpreting mortality profiles was unfortunately hampered by the fragmented nature of the assemblage, with the partial skeleton being one of only two individuals that were amenable for more precise age determinations. The intentional targeting of subadult individuals cannot be overlooked, however drawing this conclusion is hindered by the inability to estimate narrower mortality age ranges for most of the specimens.

Generally, attritional mortality profiles in cases of domesticity are indicative of a practice of animal keeping in which the production of meat is not of primary concern, which is supportive of the early Spanish accounts that dictate that dogs were utilised for the hunting of hutía, and as companion animals, as well as a source of protein (Las Casas 1909, 26, Capítulo 10). The mortality profiles therefore suggest a nuanced, multi-faceted relationship between Amerindians and dogs at these sites, although with the possibility that ritual feasting activities may have targeted younger individuals whilst certain individuals survived to maturity to serve as guardians, companions and as hunting aids.

7.4 Morphological reconstructions- were there different breeds?

The only element that allowed a reconstruction of body mass was FND 2649, a left femur belonging to a subadult individual that died between 6-9 months of age and weighed approximately 9.6 kg. When compared to dogs found regionally, this specimen exceeds the range of dog burials from the Dominican Republic, which range between 5.5 - 8.4 kg (Grouard *et al.* 2013). However, this larger size does fit into expected average weights of dogs from other areas in the Caribbean, such as at Sorcé, where 13 dogs demonstrated an average weight of 9.3 kg (Wing 1991, 382).

Two individuals exceeded the height range of dog burials that had been previously recorded in the Dominican Republic, whereas the interred skull from El Flaco (FND 2270) was of a similar height to other buried dogs. The disarticulated partial skeleton from El Carril (FND 424) belonged to an individual that reached a shoulder height of 45.9 cm. The height of this individual is considerably larger than dogs from burials previously found in the Dominican Republic, which had an average SH value of 35.4 cm (Lawrence 1977). The closest pre-colonial dog burials of similar height come from Seaview, Barbuda and average at 45.2 cm, with the tallest specimen reaching 48 cm (Grouard *et al.* 2013) (Figure 30). FND 2821, a left 5th metacarpal, belonged to an individual that reached 41.7cm in shoulder height, which similar to the partial skeleton from El Carril was significantly taller than the average stature of dogs recorded from burials in Hispaniola. Interestingly, the interred skull (FND 2270) from El Carril demonstrated a shoulder height of 35.11 cm, which is comfortably aligned with the previously recorded average of 35.4 cm for dog burials in the Dominican Republic. (Grouard *et al.* 2013).

There are disparities in the sizes of dogs recovered from multifunctional mounds compared to the interred skull that was uncovered at El Flaco. Although there is a relatively small sample size of individuals that were applicable for the reconstruction of body mass (n=1) and for shoulder height (n=3), these results demonstrate that there was a difference in stature between dogs whose remains were uncovered in non-burial contexts (FND 474; 2821; 2649) compared to the one partial skeleton that was ritually interred (FND 2270) (Figure 30). The only other sample from the two sites that was applicable for shoulder height estimation (FND 2821) was considerably taller than FND 2270 whilst only 4.2 cm shorter than the partial skeleton from El Carril. This may be an indication that there was a degree of morphological variation between individual dogs in Hispaniola, although importantly the individual dog represented by the interred skull (FND 2270) is of a normal size for dogs that were more likely to be buried in Hispaniola. To date, no dog burials have been uncovered in Hispaniola of individuals that have a shoulder height of more than 37.3 cm tall (Grouard *et al.* 2013). It is possible that the interred skull belonged to a female individual due to the absence of a saggital crest (Shigehara *et al.* 1997), however it is unlikely that sexual dimorphism could account for such size differences as is observed in this research. Particularly compared to other canid species, dogs are not considerably sexually dimorphic (Clutton-Brock 1995).

The results of the morphological reconstructions may serve as an indication of their having existed two or more different types of dogs, in not only Hispaniola but also throughout the insular Caribbean (Figure 36), as was recorded by Columbus and Las Casas. Although the sample population is small, the depositional contexts of these remains would suggest that there may have been a difference in ritual importance between larger, hound-like *mastines,* and the smaller, terrier-like *branchetes* (Columbus 1989 [1492]; Las Casas 1875a, 311, Capítulo 42). The smaller *branchetes* may have been a more highly revered companion animal and therefore more likely to be worthy of burial as may be indicated by the interred skull uncovered at El Flaco. It is these smaller dogs that are likely the lapdogs that were recorded by the early Spanish chroniclers and designated as *aon* by the 'Taíno'. It may be that larger breeds of dog were the more favoured as a food source, and as is suggested by the reconstruction of mortality ages, two of these animals (FND 424, 2649) were definitively subadult, indicating that they may have been purposefully targeted for consumption at the onset of sexual maturity, whereas the interred skull was very likely from a mature adult.

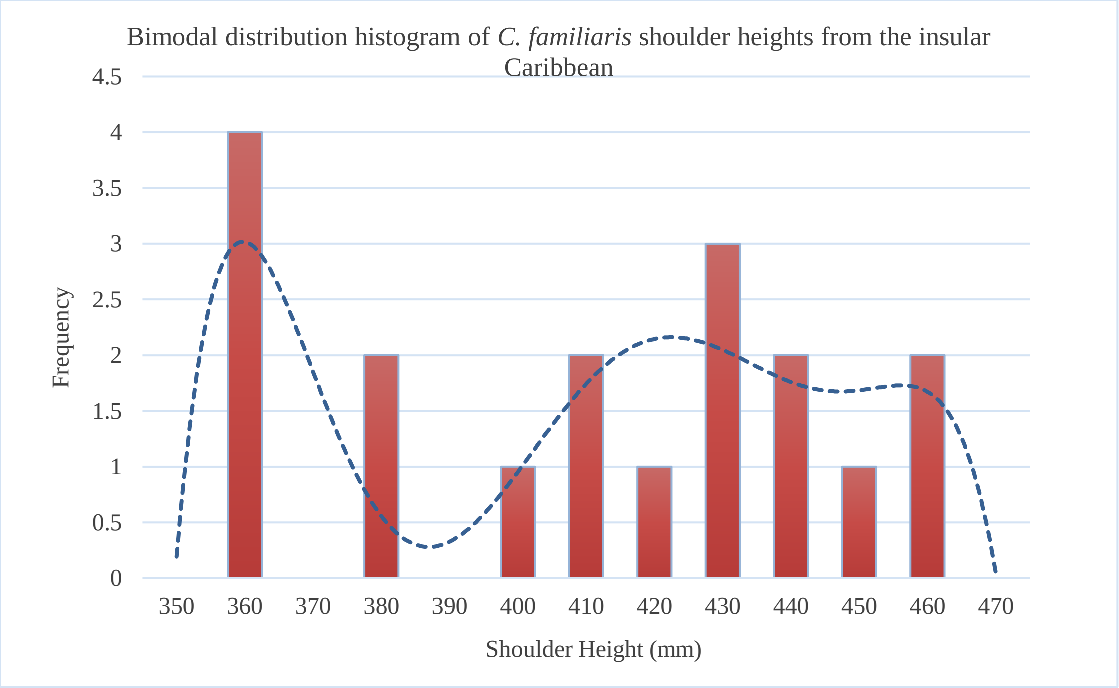


Figure 36: Histogram with polynomial trendline of dog shoulder heights in mm (*x*-axis) and the number of individuals within these ranges (*y*-axis) from various sites throughout the insular Caribbean. Amalgamates data from previously recorded dog burials from Cathédrale de Basse-Terre, Gare-Maritime Basse-Terre, Basse-Terre, Morel, Seaview Barbuda, and the Dominican Republic (see Grouard *et al.* 2013). Also included are the calculated heights of FND 424 from El Carril, and FND 2801, 2270 from El Flaco. The bimodal distribution demonstrates two distinct curves, suggesting that there were at least two different size ranges of dogs in the pre-colonial insular Caribbean.

In analysing Amerindian perspectives behind why indigenous peoples may have distinguished between different breeds of dogs an acknowledgement of the possible phenomenological reasons is worthy of investigating. Behavioural and neurophysical research support the notion that neoteny—the retention of infantile physical features—in domestic animals elicits more attentional bias and instigates more positive social engagements between humans and animals, mirroring that of the adult-infant dynamic in human relationships (Borgi and Cirulli 2016). A preference for smaller, neotenic dogs that more easily elicited emotional responses from indigenous Antilleans may be one reason for the higher reverence placed on smaller dogs in Hispaniola.

There were also likely behavioural differences between these breeds as there are amongst modern breeds. A recent behavioural study conducted on various breeds tested the responses of dogs to different stimuli and determined that smaller dogs are more likely to exhibit more aggressive behaviour to human strangers (Stone *et al.* 2016). The smaller *aon* may therefore have served as a more effective guard dog or hunter of small prey. However, nothing is currently known about the genetic lineages and likely behavioural characteristics of pre-colonial breeds to assess if behavioural differences were correlated to preferential treatment by humans.

7.5 Locality and non-locality studies in Hispaniola

High resolution assessments of locality according to strontium isotope values is problematic in the Dominican Republic. Compared to other regions in the Caribbean, such as the Lesser Antilles, little biosphere data is available for the island of Hispaniola, particularly given its relatively large size for the region. There have been some previous studies conducted on human remains at site of Punta Macao, from which one individual was deemed to have been local, exhibiting a depleted ^{87}Sr/^{86}Sr value of 0.70776, a value that is more closely aligned to pre-existing data from Puerto Rico. The other samples from Punta Macao were typical of coastal environments, these values include that which is representative of modern sea water (~0.7092) with an estimated local range of 0.7088 to 0.7092. This range of locality is like that expressed at another coastal site; El Cabo in the eastern Dominican Republic (Laffoon 2012, 186, 189-90).

A more recent multi-isotopic study by Dr Jason E. Laffoon and colleagues (2017) was undertaken on human and dog samples from the pre-colonial sites of El Cabo (*H. sapiens* n=3; *C. familiaris* n=2) and El Flaco (*H. sapiens* n=5; *C. familiaris* n=2) in the Dominican Republic. This studied provided a larger comparative sample of ^{87}Sr/^{86}Sr values specific to one of the studied sites in this research (El Flaco) and provides a juxtaposition between expected values from a coastal and an inland site respectively. In this respect, the strontium sampling undertaken in this research adds to the pre-existing data from El Flaco and has added *C. familiaris* values from the nearby pre-colonial site of El Carril.

The study by Laffoon *et al.* (2017) determined that the ^{87}Sr/^{86}Sr range for El Flaco humans was 0.7069 to 0.7083, with dogs having largely similar expressions ranging from 0.7076 to 0.7083. This contrasts to the ranges from El Cabo (humans 0.7091 to 07092; dogs 0.7090 to 0.7092), which are more typical of coastal regions. This difference reflects the distinct geological makeups of these two separate regions. El Flaco likely overlies igneous and metamorphic deposits and is situated within an inland, mountainous terrain (Donovan and Jackson 1994) and therefore exhibits more depleted bioavailable ^{87}Sr/^{86}Sr ranges, whereas El Cabo overlies karstic marine carbonates, and therefore is similar to other localities that are comprised of limestone deposits, such as at what is observed on the island of Grande-Terre in Guadeloupe (Laffoon *et al.* 2012). Current estimations for the local range of El Flaco as determined from hutía dental enamel (n=4) is 0.7062-.7080, whilst El Cabo is 0.7090-.7092 (Laffoon 2012; *et al.* 2017).

7.5.1 *C. familiaris* locality and non-locality at the sites of El Flaco and El Carril

The results from this study of dog samples taken from El Flaco and El Carril demonstrate similarities in the ^{87}Sr/^{86}Sr ranges between the two sites (Table 11). This was to be expected given their close geographical proximity and therefore likely overlying similar geologies. Both are inland sites, located on the southern foothills of the Cordillera Septentrional and similarly overlying metamorphic and igneous geologies. The range of dog remains from El Flaco (n=9) was 0.7075 to 0.7082, with four examples demonstrating slightly enriched readings that were higher than the previously estimated maximum value of 0.7080. However, given the relatively small amount of baseline strontium isotope data from this region surrounding El Flaco and El Carril, it is likely that all the specimens from this site represent dogs that were raised locally. The addition of these samples will likely extend the expected local range of bioavailable strontium values estimated for El Flaco. The dog samples from El Carril (n=7) exhibited a range of 0.7076-0.7090. Two samples (FND 716, 722) from El Carril have values of 0.7081, however like the four outliers from El Flaco, are likely of local origin to the immediate region (Figure 37).

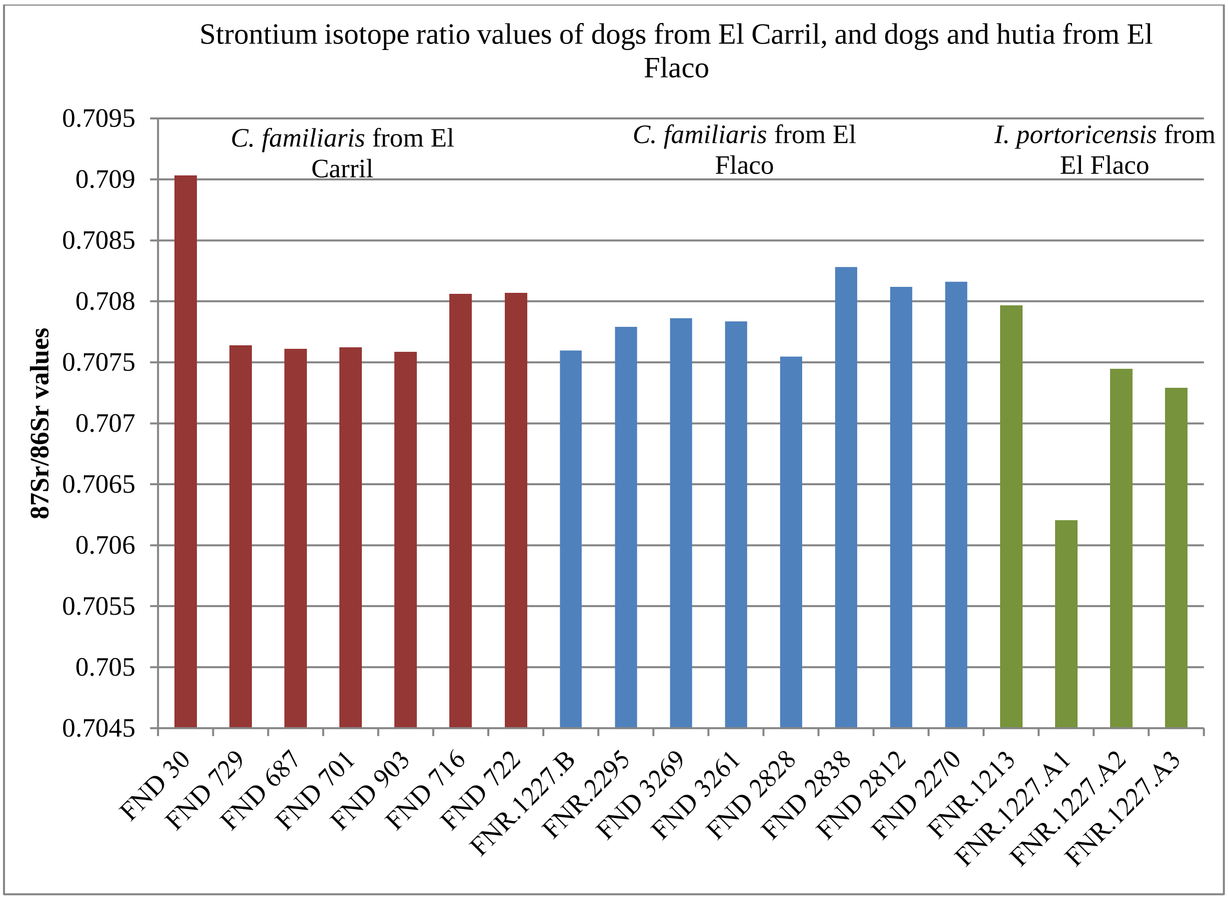


Figure 37: Strontium isotope ratio values of dogs from El Carril, and dogs and Puerto Rican hutia (*Isolobodon portoricensis*) from El Flaco. One dog sample from El Carril (FND 30) and one hutía from El Flaco (FNR.1227.A1) are distinct from the rest of the dataset, indicating that these individuals were likely non-local

One outlier sample (FND 30; $^{87}Sr/^{86}Sr = 0.7090$) far exceeded the expected local range of nearby El Flaco, and is more closely clustered to coastal sites in the Dominican Republic of which data is included in this thesis by courtesy of Dr Jason Laffoon, such as Punta Macao, Juan Dolio, El Soco, Atajadizo and La Caleta (Figure 32). It is highly likely that this individual originated from a coastal region of Hispaniola. However, given that this sample was an isolated premolar, any more biographical information beyond determining an approximate minimum age at death of five months is not feasible. An isolated tooth does not provide significant indication of the treatment of this animal during life, and it is possible that this tooth may have been lost during the life of the animal or translocated after its death. However, the coastal signature of this individual is an indication that some dogs were originating from distant regions, but whether this was the result of exchange or migration cannot currently be ascertained.

7.5.2 Carbon and oxygen values of dog remains from El Flaco and El Carril and their relation to locality

Of all *C. familiaris* from El Flaco and El Carril, only one individual (FND 30) was non-local. This sample also exhibited the most enriched $\delta^{13}C_{en}$ value (-8.8‰) and $\delta^{18}O$ value (-1.8‰) of all samples that were included in this study, regardless of species or site. The reasons for this are unknown, however the enriched carbon values can are likely attributable to a higher reliance on marine resources, a notion supported by the likely coastal location that is indicated by the strontium isotope ratio of this sample. When plotted together, $\delta^{13}C_{en}$ and $\delta^{18}O$ values of all specimens appear to demonstrate some correlation in their mutual enrichment (Figure 31).

The distinct isotopic expressions of FND 30 highlight the possibilities for determining more precise provenances when multiple isotopic values are obtained from one sample. However, as a caveat all other dog samples from El Flaco and El Carril from individuals that were determined to be of local origins (n=15) exhibited a varied range of $\delta^{18}O$ ratio values (-5.3 to -2.2‰). When correlated with the $^{87}Sr/^{86}Sr$ values of all applicable samples from humans and dogs at all sites (Figure 32), there are no observable correlations between locality and certain $\delta^{18}O$ values. This indicates that sources of environmental water that were ingested by dogs within these localities exhibited high degrees of variability in oxygen values. Recent studies have demonstrated that certain sources, particularly ponds and other closed sources of water can demonstrate high variability throughout the year (Scherer *et al.* 2015). The amount of oxygen enrichment in an organism is also dependent on how an animal obtains water, whether it is from plants or from terrestrial water sources, and according to metabolic differences between individuals. Additionally, C_3 plants have demonstrated to have more enriched $\delta^{18}O$ values than C_4 plants which can influence the oxygen enrichment of animals consuming these different types (Kohn 1996; Repussard *et al.* 2014; Sponheimer and Lee-Thorp 1999; Tuross *et al.* 2008). Considering the high number of variables that contribute to $\delta^{18}O$ values it is not possible to gain succinct information from oxygen values, so it is best used to corroborate other isotopic values such as carbon and strontium (Sharpe *et al.* 2018).

In correlating $^{87}Sr/^{86}Sr$ values with $\delta^{13}C_{en}$ values (Figure 33) from sites in the Dominican Republic and from Morel, Guadeloupe, there appears to not be any relationship between location and $\delta^{13}C_{en}$ ratio values. This may be an indication of similar subsistence strategies operating throughout the region regardless of location (Laffoon *et al.* 2017). There is considerable overlap in the human and dog $\delta^{13}C_{en}$ ratios from the Dominican Republic that would indicate the consumption of similar sources of food by both species (Table 12). However, there are definitively more enriched $\delta^{13}C_{en}$ values for dogs, with the 11 highest out of a total of 46 samples belonging to *C. familiaris*.

In summary, the $\delta^{13}C_{en}$ data of dogs from El Flaco and El Carril, like that of humans and dogs observed elsewhere in the insular Caribbean, indicates a dietary reliance on C_3 plants. Moreover, although there was clearly a reliance on C_3 resources, the notable enrichment observed in the *C. familiaris* samples from El Flaco, El Carril and Morel suggests that dogs were consuming higher quantities of C_4 and/or marine resources compared to humans. This is a pattern that has been previously observed in studies of enamel values from El Flaco, El Cabo, and Morel and Anse à la Gourde in Guadeloupe (Laffoon *et al.* 2017). To ascertain if there is a definitive pattern of enrichment in dog isotope values compared to humans, an assessment of the protein intake ascertained from collagen samples can help disentangle whether these differences in food consumption were plant or protein-based. This can importantly allow interpretations of how dogs were treated at El Flaco and El Carril according to what kinds of foods they were being fed, and how similar they were with humans in the consumption of certain types of foods.

7.6 Collagen values of dogs and humans throughout the insular Caribbean- trophic level and protein consumption

Similar to what is observed from the enamel results, the carbon ($\delta^{13}C_{co}$) and nitrogen ($\delta^{15}N$) value ranges obtained from collagen samples of dogs from all sites largely overlap with humans from the Dominican Republic (

Figure 34). The $\delta^{15}N$ values (8.2 to 13.1‰) of dogs from El Flaco and El Carril are mostly overlapping that of humans from El Cabo and El Flaco (8.8 to 11.9‰), and the same pattern applies to the $\delta^{13}C_{co}$ range of dogs from El Flaco and El Carril (-19.5 to -16.5‰) compared to the human samples from the Dominican Republic (-19.1 to -17.3‰) (Table 13; Table 14). However, mean values for $\delta^{15}N$ in dogs from El Flaco (10‰) and El Carril (9.9‰) are slightly less than human values from El Flaco (10.1‰). When calculating two standard deviations (+/- 2σ) from the mean human and dog $\delta^{15}N$ and $\delta^{13}C_{co}$ values from El Flaco and dogs from El Carril, there is a larger degree of variation in nitrogen values in dogs (Figure 38), and for the carbon values of dogs from at El Flaco but not El Carril (Figure 39). This may indicate that at the two sites dogs were consuming protein from more varied sources compared to humans. The slightly depleted δ^{15}N mean values in dogs may be associated with the human consumption of dogs (Richards *et al.* 2009), or possibly the canid behaviour of caceaotrophy (Allitt *et al.* 2008).

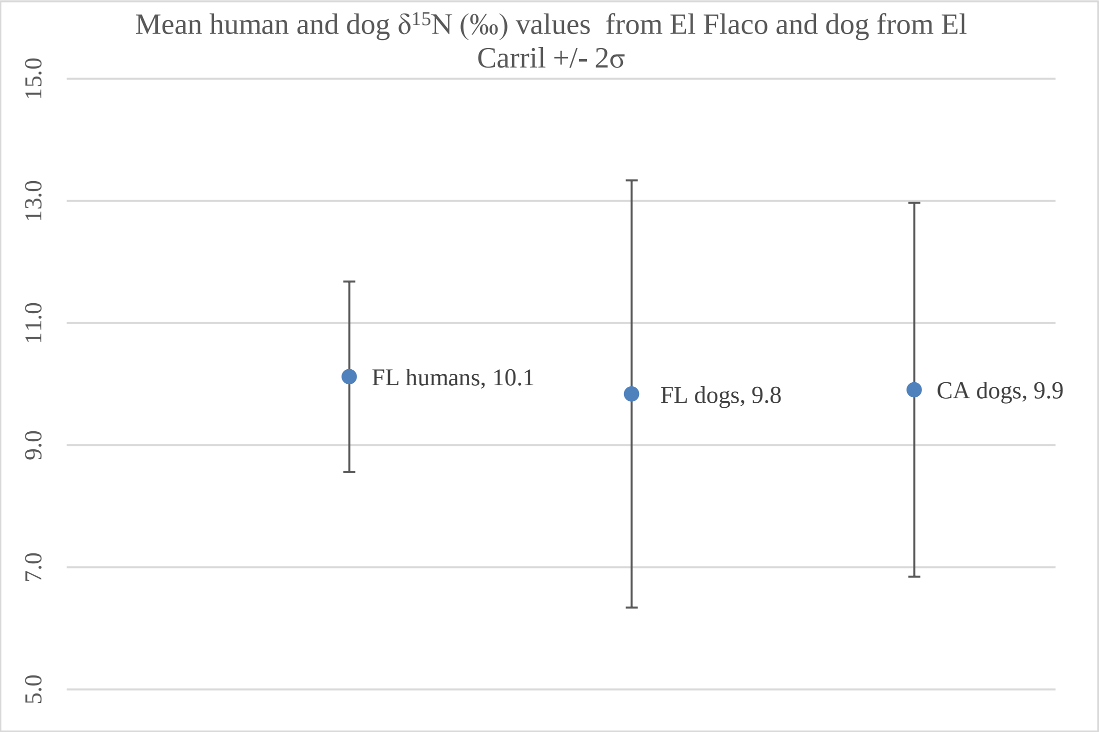


Figure 38: Mean nitrogen values of humans and dogs from El Flaco (FL) and dogs from El Carril (CA). Note the larger 2-standard deviation (2σ) represented by the error bars in the dog values, indicating a more varied dietary nitrogen intake compared to humans

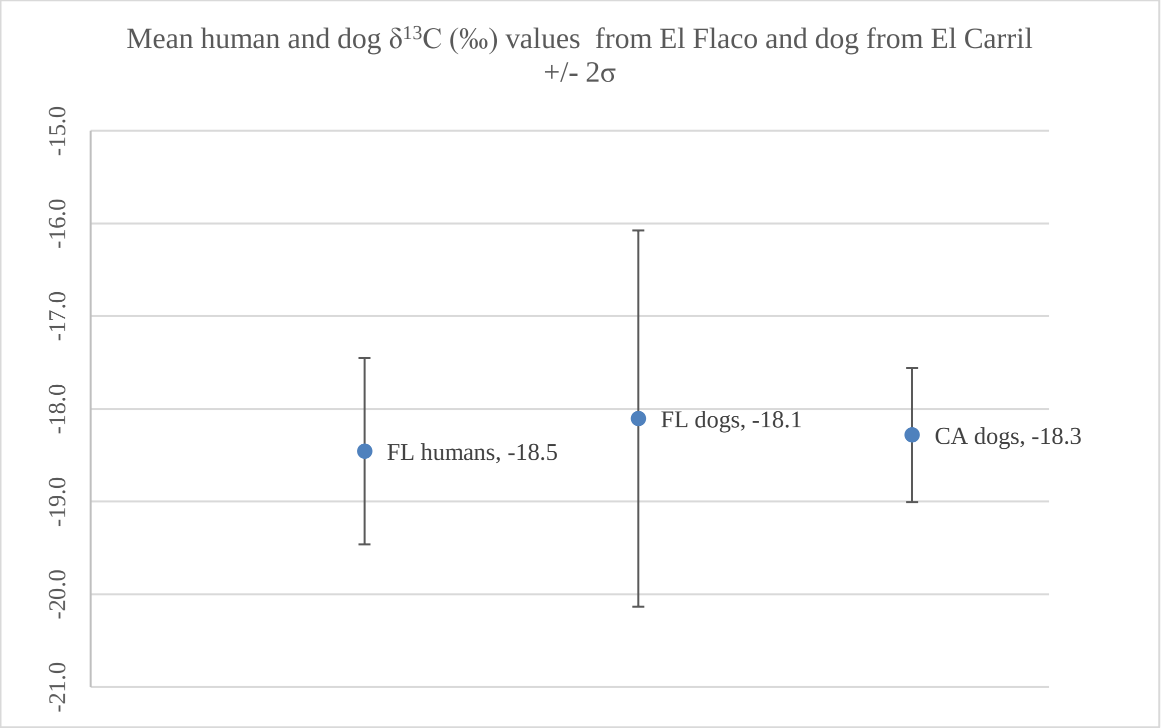


Figure 39: Mean carbon values of humans and dogs from El Flaco (FL) and dogs from El Carril (CA). Note the larger 2-standard deviation (2σ) represented by the error bars in the El Flaco dog values, indicating a more varied dietary carbon intake compared to humans at El Flaco, but similar overall carbon values at El Carril.

Concerning $\delta^{13}C_{co}$ values, the four most enriched ratio values belong to *C. familiaris* individuals from Hope Estate (n=1) and El Flaco (n=3). As a caveat, the sample from Hope Estate has both the highest $\delta^{13}C_{co}$ and second highest $\delta^{15}N$ values of all dog and human samples, however given its provenance from the Lesser Antilles and its Early Ceramic Age date, comparing this individual to that of the other samples is problematic. However, human data previously recorded by Stokes (1998) from Hope Estate indicates that the $\delta^{13}C_{co}$ of previously recorded human samples and the one dog investigated in this study are largely identical, although this individual dog exhibits comparatively enriched $\delta^{15}N$ ratio values (Table 15).

Two of the El Flaco dog samples demonstrate a relative enrichment of $\delta^{13}C_{co}$ but have the most diminished $\delta^{15}N$ values of all humans and dogs, suggesting that they were consuming higher quantities of C_4 plants but less marine resources or other sources of higher trophic level protein. The ranges of dogs from El Flaco appear to be more varied than that of El Carril and Cathédrale Basse-Terre, which both fit into the $\delta^{13}C_{co}$ range of humans. The human values from both El Cabo and El Flaco are largely clustered together, suggesting that the protein component of the human diets is similar at both sites, even though El Flaco is inland, and El Cabo is situated on the eastern littoral zone. However, the ranges exhibited in *C. familiaris* collagen and enamel values suggest that the diets of non-buried dogs were less homogenous compared to humans. The possible reasons for this will be further discussed below.

In reconstructing the dietary composition of dogs and humans from the collagen data, it appears that the mean values of $\delta^{13}C_{co}$ for both dogs and humans from the Dominican Republic (El Cabo, El Flaco and El Carril) are similar to previously recorded mean values from sites mainly located in the Greater Antilles, such as Juan Dolio and Boca del Soco in the Dominican Republic, and Maisabel, Paso del Indio, Punta Candelero and Tibes in Puerto Rico (Table 15) (Laffoon *et al.* 2017; Pestle 2010; Stokes 1998). This suggests that there were similar dietary preferences throughout the Greater Antilles, with observable differences when compared to much of the Lesser Antilles. In comparison to other regions, in particular to what has been observed at Lavoutte in St. Lucia, although marine resources were important for the people of Puerto Rico and Hispaniola, there was likely a lesser reliance on marine resources from a higher trophic level, such as larger, predatory pelagic fish (Laffoon *et al.* 2016). Archaeozoological evidence supports this notion, and there were likely different subsistence strategies and alimentary preferences existing within different regions of the Caribbean (Laffoon *et al.* 2016; Newsom and Wing 2004; Stokes 1998). From the data that has been generated, it appears that the dietary composition of dogs from the sites of El Flaco and El Carril largely mirrors that observed in other sites in the Dominican Republic and in Puerto Rico.

7.7 Differential treatment of dogs as expressed in their diets

Given that only one individual from El Flaco (FND 2270) was ritually interred, there is limited sample population from the two case study sites in this research to concretely assess if there was differential treatment affecting the treatment of dogs that were buried compared to those that were not. However, when the isotopic data is combined with that from the Lesser Antilles there is a notable uniformity in the clustering of *C. familiaris* values from buried individuals compared to the wider range and higher statistical variance in the dietary intake of dogs that were uncovered from non-burial contexts (Figure 35; Table 16). This information must be used with caution, as there are considerable temporal and regional differences between the studied assemblages from the Lesser Antilles and those in Hispaniola. For this reason, the one dog sample from Hope Estate is discounted in this analysis of differential treatment, particularly given its enriched $\delta^{13}C_{co}$ ratio value, which overlaps that of the human value from St. Martin and some other sites within the Lesser Antilles, but not for the Greater Antilles. However, Morel is included as the ranges for human enamel readings ($\delta^{13}C_{en}$ -12.9 to -11.1‰) (Laffoon *et al.* 2017) and dog ($\delta^{13}C_{en}$ -12.7 to -11.1‰) from this site are largely identical and overlap with the combined human and dog range from the Dominican Republic—when excluding the one non-local dog—from El Carril ($\delta^{13}C_{en}$ -12.6 to -10.4‰). For this reason, it is assumed that the collagen data for the Morel dogs is surrogate to human data from the same site, particularly considering the feasibility of applying the CSA, which has been positively assessed throughout this research. The two buried dogs from Cathédrale de Basse-Terre also demonstrate collagen values that are reminiscent of that of humans from the Dominican Republic. The reasons for this similarity in dietary composition between sites in the Dominican Republic, Cathédrale de Basse-Terre and Morel on Grande-Terre is poorly understood, particularly given that some nearby sites that were contemporaneous with the latter two sites such as Anse a la Gourde on Grande-Terre (Laffoon and de Vos 2011; Stokes 1998) and Hope Estate on St. Martin (Stokes 1998) demonstrate incommensurable differences in collagen values.

In summary, there is higher variation in collagen value ranges of dog remains uncovered from the multifunctional mounds at El Flaco and El Carril ($\delta^{13}C_{co}$ -19.5 to -16.5‰, range = 3.02; $\delta^{15}N$ 8.15 to 12.7‰, range = 4.59) compared to the combined data exhibited for humans and dogs from burial contexts at El Cabo and El Flaco (humans), and Morel and Cathédrale de Basse-Terre (dogs) ($\delta^{13}C_{co}$ -19.7 to -17.9‰, range = 1.85; $\delta^{15}N$ 8.8 to 11.9‰, range = 3.04). When statistical analyses are applied on dog remains that were buried compared to non-burials there is notably higher variance and standard deviations in the former compared to the latter (Table 16).

Table 16: Statistical analysis of buried dog remains from El Flaco (FND 2270) (n=1), Cathédrale de Basse-Terre (n=2) and Morel (n=6); and non-buried dog remains from El Carril (n=4) and El Flaco (n=10). Note the higher range, variance and standard deviation of non-buried dogs compared to those uncovered from burials

Collagen values of dogs according to depositional context				
	$\delta^{13}C_{co}$ (‰)		$\delta^{15}N$ (‰)	
	Burial	Non-burial	Burial	Non-burial
Arithmetic mean (μ)	-18.69	-18.13	9.69	9.90
Median	-18.55	-18.44	9.47	9.35
Range	1.91	3.02	1.94	4.93
Variance (σ2):	0.40	0.76	0.41	2.67
Standard deviation (σ)	0.64	0.87	0.64	1.63

As a caveat, the limited sample size may be a factor affecting this pattern, should more samples have been available greater variations in the $\delta^{13}C_{co}$ and $\delta^{15}N$ value ranges of buried dogs may have emerged. Should this result be more concretely ascertained with a larger sample population, one possible reason for the higher range in dogs that were not buried at El Flaco and El Carril is that dogs that were buried exhibited more of a shared diet with humans. Another possibility to consider in explaining the highly varied diets exhibited by dogs that were uncovered in multifunctional mounds is that some of these individuals may have been feral or were more reliant on the opportunistic scavenging or predation upon endemic fauna and flora.

However, contrary to this notion, the dog samples from the multifunctional mounds at El Carril are more uniformly clustered with humans. This may indicate that, although both sites were largely contemporaneous and situated near each other, there may have been a higher population of dogs that were opportunistically scavenging at El Flaco compared to El Carril. The patterns observable in the isotopic dataset may be associated with the limited sample population, as higher variances in *C. familiaris* diets may be expected if more samples were available. The previous excavations at El Carril uncovered a dog burial (Veloz Maggiolo 1972), currently on display at the Museo Centro León, Santiago de los Caballeros, Dominican Republic. An isotopic study of that individual would be beneficial for further assessing if there are any dietary differences between dogs found in burials and those that are not at this site.

An assessment of the multi-isotopic data generated in this research allows a conclusion that there was likely differential treatment that affected the dietary intakes of dogs occurring in the pre-colonial insular Caribbean; dogs that were buried alongside humans displayed similar diets to humans, whereas those that were not buried demonstrated a higher range of isotope values and therefore likely a more varied diets. This pattern is reflected in previous studies assessing the canine surrogacy approach, such as at Kodiak Island in northwest North America, where isotopic studies of *C. familiaris* and red fox (*Vulpes vulpes*) determined more uniform isotopic values for domesticated dogs which clustered close to the one human sample value. At Kodiak Island, dogs likely had a shared dietary relationship with humans, whereas foxes exhibited a wider range of collagen values, indicating a subsistence more derived from opportunistic scavenging (West and France 2015).

7.8 Response to perspectivism and the notion of the psychopomp

A central aim of this research was to provide empirical data that can aid in interpreting the perspectives governing the treatment of dogs by Amerindians in Hispaniola. Regarding notions of reciprocity and egalitarianism that govern human-animal relations as is suggested by Amerindian perspectivism, this research has generated empirical evidence that would suggest that these ontological rationales did not affect the treatment of all types of dog the same.

Much of the ritual and religious knowledge of 'Taíno' culture is lost, and therefore there are no recordings from the ethnohistorical sources of rituals governing reciprocity in the predation of certain animals, or taboos against the eating of the dog specifically. The data generated in this research suggests that there were different modes of treatment affecting different types of dogs, with morphology perhaps permitting a hierarchical distinction within the cultural taxonomy of Amerindians in Hispaniola. A heightened perception of differences between types of dogs may have been particularly exaggerated given the lack of any other large mammals in Hispaniola from which to compare. As Peter Roe (1995) has suggested, the dog likely substituted for the jaguar as a powerful totem in Antillean cosmologies, being the only relatively large predator to exist within the region.

The osteometric evidence suggests that a smaller type of dog, which may have been the animal designated as *aon* by Amerindians, was likely more highly revered and more susceptible to be ritually buried in Hispaniola, whereas the combined SIR data from both the Lesser and Greater Antilles may broadly indicate that dogs that were buried shared a closer dietary relationship with humans compared to dogs that were not. The disparate treatment of distinct breeds is exemplified in ethnographic analogies from northern South America, in which there are examples of differential treatment between well-bred hunting dogs in Trio, Waiwái and Wayana communities, who are often better cared for and fed higher quality diets compared to other dogs (Ahlbrink 1956, 46; Carlin 2017 *pers. comm.*). This difference in diet is broadly reflected in the isotopic results of this research, in that dogs that were buried were statistically less-varied in their diets, having possibly been conferred the same treatment as another person in terms of what they were given to eat. However, there is considerable overlap in the isotopic data and, so it is likely that dietary composition is not necessarily a good indicator of preferential treatment. More data is needed to further establish definitive statistical patterns that would suggest that higher degrees of homogeneity in *C. familiaris* diets is indicative of the preferential treatment of those individuals by humans.

There were undoubtedly disparate historical ecologies affecting the subsistence strategies, cultural institutions and ontologies of indigenous peoples in the pre-colonial Greater Antilles compared to antecedent and contemporary Amerindian cultures of northern Amazonia and the Orinoquia. In northern South America, there are no ethnographic records or archaeological evidences of the consumption of dogs. Additionally, there is a multitude of Amerindian folklore stories that indicate that the consumption of dogs was taboo, such as stories of the judgement of the deceased according to how they have treated dogs during their lifetimes, told by such groups such as the Cariban speaking Yukpa, Kalina and Taulipang peoples, and Arawakan speaking Lokono (Paulsen 2017 *pers. comm.*; Reichel-Dolmatoff and Reichel-Dolmatoff 1961, 380; Villamañán 1982, 19-20; Wilbert 1974, 6). Unlike Amazonia, in Hispaniola and for much of the insular Caribbean, there were likely no taboos preventing the consumption of dogs in general, although there may have been culturally enforced taboos preventing the consumption of the smaller *aon* type. In this respect, the evidence from the insular Caribbean suggests that the consumption of dogs was not taboo, and the ontological rationale underlying the treatment of dogs may have been more akin to what is observed in pre-colonial Mesoamerica, if a broad analogy from the greater Americas region is needed. In Mesoamerica, there is no evidence of a utilitarian distinction between different breeds and their propensity to be sacrificed, eaten or ritually buried (Valadez Azúa *et al.* 2013, 558), this may indeed be the case for Hispaniola, however further morphological reconstructions of dogs uncovered from both burials and multifunctional mounds are needed to verify this.

As it stands, this research suggests that there was likely an ontological distinction between larger and smaller types of dogs which effected their treatment by humans in life and in death. It is possible that the smaller *aon* was considered consanguineous with humans, and therefore meriting ritual burial as is evidenced at sites in Hispaniola, including the buried individual uncovered at El Flaco. Larger types of dog were perhaps not worthy of this treatment and were therefore situated lower in the cultural taxonomy of Amerindians, and not regarded as consubstantial and metaphysically equivalent nonhuman person. This is in line with perspectival theory, in that not all animals are applied with the same notions of personhood or symbolic importance, whereas some are definitively considered as non-consubstantial prey (Descola 2005; Viveiros de Castro 1998; 2015, 204). A distinction was likely made between a pet that is not eaten—a practice which is well-documented in Amazonian ethnographic studies—and a morphologically distinct dog for which it was permitted to consume. It is also likely that these different types, like modern breeds, had different behavioural characteristics. The smaller *aon* may have been a more adequate and aggressive hunter or guard dog, as suggested by Las Casas (1929, 165), perhaps leading to higher regard being conferred on this type of dog in Hispaniola, as is reflected in their ritual treatment in death.

The dog as a species does not fit neatly into Amerindian perspectival theories. The limitations of Amerindian perspectivism lie in that to function as a viable interpretation of pan-Amerindian ontologies, the worldviews of the complex civilisations of Mesoamerica and the Andes must be considered as separate from that of hunter-gatherer and horticulturalist communities in Amazonia or elsewhere in the Americas. In this respect, the theory suffers from a selectiveness in what cultures it chooses to essentialise in providing a coherent and succinct overview of myriad Amerindian cultural rationales. The limitations of applying Amerindian perspectivism to the pre-colonial Antillean cultures is demonstrated in this research in trying to ascertain the role of dogs—a creature whose relationships with humans are undoubtedly nuanced, complex and archaic in origins—particularly due to the fact that the best archaeological analogies of human-canid relations come from regions that are purposefully excluded from Amerindian perspectivism, which however hold the richest archaeological evidence of the varied roles of dogs within the pre-colonial Americas.

The ritual treatment of larger dogs and smaller *aon* dogs with humans appears disparate according to the data. This would indicate that the smaller type was considered to have been worthy of the same rites that would normally be conferred to a person after death. The interred individual represented by the skull and innominates at El Flaco, due its proximal association with numerous human burials, is indicative that there was some ritual significance conferred on this animal. However, its incomplete nature suggests that it was not a burial like other instances that have been uncovered in the insular Caribbean. Elsewhere in the Americas, in particularly the Andes and Mesoamerica, select elements of dogs have been uncovered in association with human burials, likely signifying an offering of food for the deceased, or as totems to act as guides after death. For example, in the Andes the internment of *C. familiaris* cranial elements in human burials at Mochica sites indicates that the dog acted as a symbolic psychopomp (Goepfort 2012). Whereas in Mesoamerica, although the role of dogs varied from companion, to food source, to sacrificial victim, the multitude of isolated dog remains that have been uncovered in association with human burials have been interpreted as food offerings for the deceased (Valadez Azúa *et al.* 2013, 577-8).

For lack of more informative sources regarding the ritual practices of the 'Taíno' beyond what was recorded by Fray Ramon Pané, it can be deduced that the skull and innominates buried alongside humans at El Flaco represents a burial offering. Given the size of the animal, fitting into the average for dog burials in Hispaniola, suggests that this internment was possibly a purposefully selected offering to the deceased, made to assist with their passage to the island of the dead, Coabay. It is possible that the dog, or even the *aon* breed specifically, could in times act as the totemic embodiment of the guardian of the dead *cemí, Opiyelguobirán*, necessitating the burial of this animal alongside the recently deceased to act as a guardian and guide to the next life. This extends the role of the dog beyond companionship, beyond a food source, and to hold a pivotal role within the cosmological perspectives of the indigenous peoples of Hispaniola.

Chapter Eight: Conclusion

8.1 Introduction

This project has employed a multi-disciplinary approach in investigating human-canid relationships in Late Ceramic Age Hispaniola. An investigation of *Canis lupus familiaris* remains from the two case study sites in the Dominican Republic, El Flaco and El Carril, has revealed that there potentially existed two different breeds in Hispaniola prior to the arrival of Europeans in 1492. This multi-disciplinary approach served to answer the main research question of this project:

> How can the data garnered from the synthesis of techniques from the biological sciences be interpreted according to Amerindian perspectival theory, ethnographic analogy and ethnohistoric sources to understand the cultural rationales governing the dualistic treatment of dogs in the pre-colonial insular Caribbean?

It is feasible that different breeds were subject to differential treatment in the pre-colonial Caribbean, with a notable preference for the ritual interment of the smaller type, as is evidenced with the one example of an interred skull and pelvis that was recovered from El Flaco. Additionally, the multi-isotopic studies have revealed that there were shared dietary relationships between humans and dogs at these two sites, validating the canine surrogacy approach for the region. The addition of data from previously conducted isotopic studies in Hispaniola (Hofman *et al. in prep*; Laffoon 2017; *et al.* 2017) and extra dog bone samples from the Lesser Antilles has enabled interregional and inter-temporal comparisons with the isotopic data from the two case study sites of El Flaco and El Carril. This additionally data allowed an interregional comparison of dog palaeodiets of individuals from burial and non-burial contexts, illustrating higher variance in the dietary signatures of dogs that were recovered from non-burial contexts. When interpreted through a perspectival framework, distinctions in morphology perhaps permitted the higher taxonomic placement of the smaller type of dog over that of the larger according to indigenous perspectives, therefore providing conditions for the burial of this particular breed with the same rites as that normally conferred on a person.

This chapter provides conclusive answers to the research questions that were posed in Chapter One and highlights potential directions for future studies that would expand our knowledge regarding human-animal relations in the pre-colonial insular Caribbean.

8.2 The treatment of dogs in pre-colonial Hispaniola

> What can be determined about the treatment conferred on dogs by the indigenous inhabitants of Hispaniola according to data gained from archaeozoological investigation?

The data generated by the analysis of bone surface modification, mortality age determinations and morphometric reconstructions illuminated the nuanced role and treatment of dogs by the pre-colonial inhabitants of El Flaco and El Carril. No conclusions can be concretely made as to whether dogs were being predated upon by humans at these sites, given the notable absence of bone surface modification resultant of cooking, or of markings on bones that could be unequivocally associated with butchery practices on the clear majority of remains. The only specimens that demonstrated possible butchery were two tibiae belonging to a disarticulated skeleton that was recovered from El Carril. Given the similar arrangement of these markings and the absence of any axial or cranial elements associated with this individual, it is highly likely this animal underwent some form of butchery. Ethnographic studies have shown that during butchery the fore and hind legs of an animal are often disarticulated and treated differently to the rest of the body. The bone surface markings observed on these bones possibly represent skinning or disarticulation activity (Binford 1981). Unfortunately, these markings could not be safely attributed to a lithic tool due to the shallowness of the grooves and lack of internal striations, however it may be possible that these were made using shell or some other material. Even so, the evidence suggests that this individual was purposefully disarticulated, but for what purposes is currently undetermined.

The age profiles generated in this research suggest that the mortality patterns of dogs from both sites were largely attritional in nature. There was evidently a significant percentage of juvenile animals (14.29%) that died under 5 months old, however most specimens were likely at breeding age at death. Additionally, almost a quarter of all dogs were likely not over 12 months of age and therefore had not reached full skeletal maturity. Attritional profiles can be associated with natural rates of mortality, however in situations of domesticity are also an indication that animals are reared for purposes when meat is of secondary concern. These profiles suggest that dogs were not being farmed for their meat, and likely served a multi-purpose role within indigenous societies, a notion that is supported by the ethnohistoric sources that mention that dogs were both companions, hunting aids, and a source of food.

The only buried *C. familiaris* individual recovered from both sites is represented by the ritually interred skull and pelvis recovered from El Flaco, and the previously recorded dog burial from El Carril that was excavated by Veloz Maggiolo in the last century. Interestingly, morphometric reconstructions conclude that the ritually interred skull from El Flaco belonged to an animal that was similar in shoulder height to four previously excavated dog burials from the Dominican Republic, whilst two other non-buried specimens demonstrated shoulder heights that far exceeded that of buried dogs from Hispaniola (Grouard *et al.* 2013; Lawrence 1977). These results indicate that there may have been at least two different breeds in the region that were susceptible to differential treatment by humans. The ethnohistoric sources recorded that there were two types of dogs encountered by early European explorers, designated according to their perceived similarities to European breeds as hound-like *mastines*, and the smaller, terrier-like *branchetes* (Columbus 1989 [1492]; Las Casas 1875a, 311, Capítulo 42). Las Casas mentioned the presence of small lapdogs designated as *aon* that were lavished with affection by the 'Taíno' and were used as hunting aids for the targeting of endemic rodents and birds (Las Casas 1929, 165). It is likely that these smaller *aon* were the *branchetes* mentioned in Columbus' diary and being the more highly revered animal were more likely to receive ritual treatment in death compared to their larger brethren.

8.3 Multi-isotopic analysis, the canine surrogacy approach and dichotomous treatment

A multi-isotopic analysis of bone collagen and dental enamel of dogs from the sites of El Flaco and El Carril, plus comparative samples from the Lesser Antilles, was correlated with previously recorded human and dog data from the Greater Antilles (see Hofman *et al. in prep*; Laffoon 2017; Laffoon *et al.* 2017; Pestle 2010) and the Lesser Antilles (Stokes 1998), to answer the following research question:

> Can multi-isotopic analyses of dog remains illuminate human-influenced feeding regimes, preferential treatment and shared dietary relationships with humans?

The analysis of dental enamel and bone collagen of *C. familiaris* remains from El Flaco and El Carril revealed that this animal shared a close dietary relationship with humans. In this respect, the results of this research have validated the canine surrogacy approach for pre-colonial Hispaniola. In terms of the mobility and exchange of dogs, only one individual (FND 30) was non-local, suggesting that most dogs were raised locally to these sites. The results of the stable isotope ratio analysis indicated shared foodways between the human and canine inhabitants of the sites.

In a cross-analysis of collagen data obtained from the Lesser Antilles and previously recorded enamel and collagen data from the Greater and Lesser Antilles (Hofman *et al. in prep*; Laffoon 2017; Pestle 2010; Stokes 1998), there are notable differences in diets interregionally at least in terms of protein consumption, which is a conclusion that has been determined from previous studies. This indicates that there were differences in alimentary choices operating across the insular Caribbean (Laffoon 2012; *et al.* 2017). However, the data generated in this research suggests that diets were similar between Cathédrale de Basse-Terre and Morel in Guadeloupe, and what has been recorded for El Flaco and El Carril (Laffoon *et al.* 2017), the reasons for which are unknown, particularly given the geographical and temporal separation between both regions. Again, a cross-analysis of dog and human values suggests that the canine surrogacy approach is applicable to much of the insular Caribbean, whereas dogs largely share dietary relationships with humans, these diets are dependent on the specificities of the local cuisine and locally available resources.

In determining whether palaeodietary reconstruction can be used as an indicator of preferential treatment affecting dogs by humans, there is no concrete validation that dogs that were buried were fed different diets to dogs that were not. However, there is higher statistical variance evident in the values of dogs from non-burial contexts compared to those that were buried. This possibly suggests that non-buried dogs were more reliant on scavenging, whereas those from burials may have had a more controlled diet, having been better cared for. However, the limited sample size from El Flaco and El Carril, particularly with samples obtained from burial contexts, is a limitation that cannot be overlooked, should more samples of buried dogs be analysed then higher variance may be expected.

8.4 The Amerindian perspective of the dog

In drawing ethnographic analogies from South America there appears to be some similarities regarding the role and the treatment of dogs in pre-colonial Hispaniola compared to modern and antecedent cultures in Oriniquoa and Amazonia, especially the noted special treatment conferred on hunting dogs in lowland South America and the mythological role of dog-like spirits as psychopomps. The role of dogs in the pre-colonial insular Caribbean in indubitably nuanced, as is suggested by the archaeological evidence and the accounts of early European chroniclers. However, the archaeological evidence from Mesoamerica and the Andes may be more analogous to the dichotomous role of dogs in Hispaniola than what has been recorded in Arawakan and Cariban speaking communities in northern South America, in which the consumption of dogs is largely taboo.

In Hispaniola, taboos affecting the differential treatment of dogs likely existed; however there appears to be a notable higher placement of the smaller *aon* in the cultural taxonomy of the indigenous peoples of Hispaniola, compared to its larger cousins. The perspectival reasoning for this is apparent. The size, capacity for neoteny and potential higher suitability in using this smaller animal as a hunting dog for targeting endemic rodents and birds, may have all aided in the distinguishing of this particular breed as more important compared to larger types. These perceived benefits and morphological distinctions perhaps permitted Amerindians to see the *aon* as more consubstantial, and more valued as a nonhuman person worthy of the same ritual treatment in death as one’s human kin.

Even so, more data is needed to ascertain that the smaller *aon* was the only breed of dog that was indeed buried in Hispaniola, and it may indeed turn out that this animal may have undergone treatment analogous to the multi-purpose role of dogs in Mesoamerica, in which all five determined pre-colonial breeds were equally subject to ritual burial, becoming a funerary offering, or actively feasted upon by people (Valadez Azúa *et al.* 2013).

The inhumation of the *aon* alongside deceased at El Flaco may have been a totemic funerary offering, effectively acting as a psychopomp. The ‘Taíno’ guardian of the dead *cemí Opiyelguobirán* resembled a dog in depiction and in behaviour, as was recorded by Fray Ramon Pané, so perhaps the internment of this animal alongside humans was an offering as the corporeal manifestation of *Opiyelguobirán*, made to assist the deceased in their passage to Coabay. In lowland South American Amerindian folklore traditions, the dog is often featured as a psychopomp, however this is a trope which is reflected in countless cultures and regions around the globe. No other animal shares such varied utilitarian and symbolic role in human societies as the dog.

8.5 Scope for future research

Many of the limitations of this study were associated with the limited sample size of dog remains from El Flaco and El Carril. In this respect, the results which indicate distinctions in morphology and therefore likely different breeds may be reinforced with further access to more *Canis lupus familiaris* specimens from Hispaniola, and perhaps elsewhere in the Greater Antilles. This applies to the isotopic samples as well, an increase in sample population may be able to more accurately highlight whether there was differential treatment affecting the diets of these animals. A thorough investigation would be benificial to ascertain why dog remains are limited at both sites. Moreover, as to why both fragmented human and dog remains are uncovered within the multifunctional mounds at both sides alongside fragmented human remains is a question worth investigating.

Beyond reconstructing morphology, perhaps the most succinctly useful technique in determining if there were two different breeds in the region would be the successful analysis of aDNA of dog remains from the region. Unfortunately, perhaps due to poor preservation conditions in the tropics, previous studies conducted on dog teeth have failed (Hofman 2018, *pers. comm*). The data gleaned from this line of research may also be able to ascertain the origins of Antillean dog breeds, determining whether they arrived with Saladoid peoples from South America, or somewhere else from the mainland Americas, similar to what has been conducted on guinea pigs in determining their mainland origins (see Kimura *et al.* 2016).

In light of the limitations evident in the butchery analysis, there appears to be a lack of literature regarding material studies of the use of shell in the insular Caribbean as a possible tool in the butchery of animals. Experiments have indicated that bivalve shell would make a poor instrument for the purposes of working bone (Lammers-Keijsers 2007, 51), however there are no studies indicating the efficacy of using shell for defleshing activities. Experimental archaeology may be able to ascertain the efficacy of this material and what the resulting markings on bones may look like, should it be useful as an effective tool for either skinning or defleshing an animal. More generally, experimental butchery studies using all known non-perishable tools (lithic and shell) recovered from archaeological sites in the Greater Antilles would indubitably aid in any interpretations of the methods used in butchery.

The coupling of archaeozoological and multi-isotopic analyses allows a more holistic interpretation of the treatment affecting an animal in life and in death and serves as an important approach for trying to develop a more complete understanding of the functioning of human-animal relationships in the past. A further application of this multi-disciplinary approach in the analysis of not only dog, but other species, would undoubtedly be beneficial for examining human-animal relationships and entanglements. This approach is particularly relevant for a region such as the pre-colonial insular Caribbean, for which our knowledge of the indigenous cultural institutions and environmental perspectives is unfortunately limited. In line of expanding this multi-disciplinary approach to the analysis of other fauna, an isotopic analysis of hutía (*Isolobodon portoricensis*) may reveal possible human influence in the diets of this animal. A more thorough archaeozoological and isotopic investigation may be able to ascertain whether captive management and possible proto-domestication was occurring with this species. A study in this capacity could have important ramifications in altering our understanding of the subsistence strategies and environmental management practices of indigenous Antilleans.

Abstract

The introduction of the domestic dog (Canis familiaris) in the insular Caribbean likely occurred during the Early Ceramic Age (c. 400 BC – AD 500), coinciding with the arrival of Saladoid peoples and the fluorescence of Huecoid cultures in the Greater and Lesser Antilles. However, the precise regional origins of this animal are currently unknown. Numerous studies have indicated the feasibility of using dogs as an isotopic surrogate for palaeodietary reconstruction in humans, which is telling of the high level of entanglement of humans and dogs expressed in the sharing of foodways. Shared dietary relationships with humans, ritual interment and symbolic depictions of dogs raise questions about the nuanced placement of this animal within the indigenous cultural taxonomies of the insular Caribbean. Dog remains are found both ritually interred and in domestic contexts throughout the region, suggesting that dogs were both highly valued as companions, and also possibly seen as a viable source of food. In order to understand this dichotomous treatment Viveiros de Castro’s “Amerindian perspectivism” and Descola’s notions of “animism” provided theoretical frameworks in which to analysis how dogs featured within the cosmological and cultural taxonomy of pre-colonial peoples in the insular Caribbean. For this study, data generated from archaeozoological and multi-isotopic analyses of dogs from the pre-colonial sites of El Flaco and El Carril in the Dominican Republic was compared to findings from three select sites in the Lesser Antilles: Cathédrale de Basse-Terre and Morel in Guadeloupe, and Hope Estate in St Martin. The aim of this research was to: a) establish the effectiveness of the isotopic surrogacy approach in the Caribbean; b) examine any regional differences reflected in the diets of dogs; c) determine if there are any observable distinctions in the morphology and diets of buried dogs and those uncovered from non-burial contexts; d) and to interpret why this dichotomous treatment was occurring using a perspectival theoretical framework. The results indicate that there may have been at least two morphologically distinct types of dogs in Hispaniola in support of what is mentioned in the ethnohistorical sources. These types likely underwent differential treatment by humans, with one particular type more inclined to be buried suggesting a higher value placed on this breed as a valued companion and consubstantial nonhuman person. The burial of one individual dog alongside the deceased at El Flaco may be a funerary offering, representing a psychopomp in the likeness of the ‘Taíno’ guardian of the dead *cemí*, *Opiyelguobirán*.

Bibliography

Ahlbrinck, W., 1956. *Op zoek naar de Indianen. Verslag van een expeditie naar de zuidgrens van Suriname ter opsporing en bestudering van twee onbekende Indianenstammen: de Wama's en de Wajarikoele's.* Amsterdam: Koninklijk Instituut voor de Tropen.

Alberti, B., 2016. Archaeologies of ontology. *Annual Review of Anthropology* 45, 163-79.

Alexander, R.M., A.S. Jayes, G.M.O. Maloiy and E.M. Wathuta, 1979. Allometry of the limb bones of mammals from shrews (Sorex) to elephants (Loxodonta). *Journal of Zoology* 189, 305-314.

Allen, A., 2010. Credibility and incredulity: A critique of Bartolomé de Las Casas's 'A short account of the destruction of the Indies'. *The Gettysburg Historical Journal* 9 (5), 43-8.

Ambrose, S.H., 1990. Preparation and characterization of bone and tooth collagen for isotopic analysis. *Journal of Archaeological Science* 17, 431-51.

Ambrose, S.H., B.M. Butler, D.B. Hanson, R.L. Hunter-Anderson, H.W. Krueger, 1997. Stable isotope analysis of human diet in the Marianas Archipelago, Western Pacific. *American Journal of Physical Anthropology* 104, 343-61.

Ambrose, S.H. and L. Norr, 1993. Experimental evidence for the relationship of the carbon isotope ratios of whole diet and dietary protein of those of bone collagen and carbonate, in J.B. Lambert and L. Norr (eds), *Prehistoric Human Bone. Archaeological at the Molecular Level.* New York: Springer, 1-38.

Anderson, S. and K. Boyle, 1996. *Ritual treatment of human and animal remains*. Oxford: Oxbow Books.

Antón, S.C., 2008. Human remains from the Río Tanamá sites (AR-38 and AR-39), in L.A. Carlson (ed), *A Multidisciplinary Approach to Site Testing and Data Recovery at Two Village Sites (AR-38 and AR-39) on the Lower Río Tanamá, Municipality of Arecibo, Puerto Rico.* Jacksonville: Southeastern Archaeological Research, Inc., 149-90.

Anyonge, W., 1993. Body mass in large extant and extinct carnivores. *Journal of Zoology* 231, 339-350.

Århem, K., 1993. Ecosofía makuna, in F. Correa (ed), *La selva humanizada: Ecología alternative en el tropic húmedo colombiano*. Bogotá: Intituto Colombiano de Antropología, Fondo fen Colombia, Fondo Editorial Cerec, 109-26.

Århem, K., 1996. The cosmic food web: human-nature relatedness in the Northwest Amazon, in P. Descola and G. Pálsson (eds), *Nature and society: Anthropological Perspectives*. London: Routledge, 185-204.

Arrom, J.J., 1989. *Mitología y artes prehispánicas de las Antillas*. México City: Siglo XXI Editores.

Balakrishnan, M., C.J. Yapp, D.J. Meltzer, and J.L. Theler, 2005. Paleoenvironment of the Folsom archaeological site, New Mexico, U.S.A., approximately 10,500 14C yr BP as inferred from the stable isotope composition of fossil land snail shells. *Quaternary Research* 63, 31-44.

Barad, K., 2007. *Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning*. Durham: Duke University Press.

Bataille, C.P., J.E. Laffoon and G.J. Bowen, 2012. Mapping multiple source effects on the strontium isotopic signatures of ecosystems from the circum-Caribbean region. *Ecosphere* 3 (12), 1-24.

Bateman, J.K., 1952. Injuries in the stifle joint in young Greyhounds. *Veterinary Record* 64, 786.

Benecke, N., 1987. Studies on early dog remains from northern Europe. *Journal of Archaeological Science* 14 (1), 31-49.

Bennett, C.F. Jr., 1962. The Bayano Cuna Indians, Panama: an ecological study of livelihood and diet. *Annals of the Association of American Geographers* 52, 32-50.

Bentley, R.A., 2006. Strontium isotopes from the earth to the archaeological skeleton: a review. *Journal of Archaeological Method and Theory* 13, 135-87.

Berezkin, Y., 2014. 'The black dog at the river of tears': some Amerindian representations of the passage to the land of the dead and their Eurasian roots. *Forum for Anthropology and Culture* 2, 130-70.

Bernáldez, A., 1856. *Historia de los reyes Católicas D. Fernando y Da. Isabel. Crónica inédita del Siglo XV,* vol. 1. Grenada: José Maria Zamora.

Bianchi, G., F. Angerosa, L. Camera, F. Reniero and C. Anglani, 1993. Stable carbon isotope ratios ($^{13}C/^{12}C$) of olive oil components. *Journal of Agricultural and Food Chemistry* 11, 1936-40.

Binford, L.R., 1981. *Bones: ancient men and modern myths*. Orlando: Academic Press.

Blanco Padilla, A., B. Rodríguez Galicia and R. Valadez Azúa, 2009. *El studio de los cánidos arquelógicos del México prehispánico*. Mexico City: Instituto Nacional de Antropología e Historia, Universidad national autónoma de México.

Blick, J.P., A. Bankston, C. Campbell, J. Jackson, S. Lasting, E. Mixon and L. Smith, 2016. Dogs of the Bahamas and Caribbean: evidence from Columbus' *Diario,* historical documents, and archaeology, in R. Erdman and R. Morrison (eds), *Proceedings of the Fifteenth Symposium on the Natural History of the Bahamas*. San Salvador: Gerace Research Centre, 109-23.

Blumenschine, R.J., C.W. Marean and S.D. Capaldo, 1996. Blind tests of inter-analyst correspondence and accuracy in the identification of cut marks, percussion marks, and carnivore tooth marks on bone surfaces. *Journal of Archaeological Science* 23, 493-507.

Bochaton, C., S. Bailon, I. Ineich, M. Breuil, A. Tresset and S. Grouard, 2016. From a thriving past to an uncertain future: zooarchaeological evidence of two millenia of human impact on a large emblematic lizard (*Iguana delicatissima*) on the Guadeloupe Islands (French West Indies). *Quaternary Science Reviews* 150, 172-83.

Bocherens, H., O. Sandrock, O. Kullmer and F. Schrenk, 2011. Hominin palaeoecology in Late Pliocene Malawi: first insights from isotopes (^{13}C, ^{18}O) in mammal teeth. *South African Journal of Science* 107 (3-4), 1-6.

Bökönyi, S., 1969. Archaeological problems and methods of recognising animal domestication, in P.J. Ucko and G.W. Dimbleby (eds), *The Domestication and Exploitation of Plants and Animals*. London: Duckworth, 219-29.

Bökönyi, S., 1975. Vlasac: an early site of dog domestication, in A.T. Clason (ed), *Archaeozoological Studies*. New York: American Elsevier, 167-78.

Bökönyi, S., 1983. Domestication, dispersal and use of animals in Europe, in L. Peel and D.E. Tribe (eds), *Domestication, Conservation and Use of Animal Resources.* Amsterdam: Elsevier, 1-20.

Bökönyi, S., 1989. Definitions of domestication, in. J. Clutton-Brock (ed), *The Walking Larder: Patterns of Domestication, Pastoralism, and Predation*. Cambridge: Unwin, 1-4.

Bond, W.J., F.I. Woodward and G.F. Midgley, 2005. The global distribution of ecosystems in a world without fire. *New Phytologist* 165 (2), 525-38.

Bonnet, C., L. Chaix, P. Lenoble, J. Reinold and D. Valbelle, 1989. Sépultures à chiens sacrifiés dans la Vallée du Nil. *Cahier de Recherche de l'Institut de Papyrologie et d'Egyptologie de Lille* 11, 25-39.

Bonnichsen, R., 1979. Pleistocene bone technology in the Beringian Refugium. *Archaeological Survey of Canada Paper, Mercury Series* (Paper no. 89). Ottawa: National Museum of Canada.

Bonnissent, D. and T. Romon, 2004. *Fouilles de la Cathédrale de Basse-Terre, Guadeloupe*. Document Final de Synthese INRAP, Service Regional de l'Archeologie Guadeloupe.

Booden, M.A., R.G.A.M. Panhuysen, M.L.P. Hoogland, H.N. de Jong, G.R. Davies and C.L. Hofman, 2008. Tracing human mobility with ^{87}Sr/^{86}Sr at Anse a la Gourde, Guadeloupe, in C.L. Hofman, M.L.P. Hoogland and A.L. van Gijn (eds), *Crossing the Borders: New Methods and Technioques in the Study of Archaeological Materials from the Caribbean*. Tuscaloosa: University of Alabama Press, 214-25.

Borgi, M. and F. Cirulli, 2016. Pet face: mechanisms underlying human-animal relationships. *Frontiers in Psychology* 7 (298), 1-11.

Botella, M., I. Alemán and S. Jiménez, 2000. *Los huesos humanos. Manpulación y alteraciones*. Barcelona: Ediciones Bellaterra.

Bourget, S. 1994. *Bestiaire sacré et flore magique: ecologie rituelle de la culture Mochica, côte nord du Pérou*, Vol. 1. Montreal (unpublished Ph.D. thesis Université de Montréal).

Braadbaart, F., I. Poole, and AA. Van Brussel, 2009. Preservation potential of charcoal in alkaline environments: An experimental approach and implications for the archaeological record. *Journal of Archaeological Science* 36, 1672-9.

Brugal, J.P. and F. David, 1993. Usure dentaire, courbe de mortalite et saisonnalite: les gisements du Paleolithique moyen a grands bovides, in J. Desse and F. Audoin- Rouzeau (eds), *Exploitation des Animaux Sauvages a Travers le Temps. XIII_ Rencontre Internationales d'Archeologie et d'Histoire d'Antibes.* IV Colloque international de l'Homme et de l'Animal. Juan-les-Pins: APDCA, 62-77.

Budd, P., M. Montgomery, B. Barreiro and R.G. Thomas, 2000. Differential diagenesis of strontium in archaeological human dental tissues. *Applied Geochemistry* 15, 687-94.

Bullen, R.P. and A.K. Bullen, 1973. Stratigraphic tests at two sites on Guadeloupe, in *Proceedings of the Fourth International Congress for the Study of the Pre-colonial Cultures of the Lesser Antilles*. St. Lucia: St. Lucia Archaeological and Historical Society, 192-6.

Bunn, H.T., 1983. Evidence on the diet and subsistence patterns of Plio-Pleistocene hominids at Koobi Fora, Kenya, and at Olduvai Gorge, Tanzania, in J. Clutton-Brock and C. Grigson (eds), *Animals and Archaeology*. London: British Archaeological Reports, 21-30.

Burleigh, R. and D. Brothwell, 1978. Studies of Amerindian dogs: Carbon isotopes in relation to maize in the diet of domestic dogs from early Peru and Ecuador. *Journal of Archaeological Science* 5 (4), 355-62.

Calderón, F.L., 1985. Antropologia y paleopatologia de los pobladores del Soco, in *Proceedings of the tenth International Congress for the Study of the Pre-colonial Cultures of the Lesser Antilles*. Montreal: Centre de Recherches Caraibes, 287-94.

Cannon, A., H.P. Schwarcz and M. Knyf, 1999. Marine-based subsitence trends and the stable isotope analysis of dog bones from Namu, British Columbia. *Journal of Archaeological Science* 26 (4), 399-407.

Capaldo, S.D. and R.J. Blumenschine, 1994. A quantitative diagnosis of notches made by hammerstone percussion and carnivore gnawing on bovid long bones. *American Antiquity* 59 (4), 724-48.

Capone, D.G. and E.J. Carpenter, 1982. Nitrogen fixation in the marine environment. *Science* 217, 1140-2

Carlin, E.B., 2002. Patterns of language, patterns of thought: the Cariban languages, in E.B. Carlin and J. Arends (eds), *Atlas of the Languages of Suriname*. Leiden: KITLV Press, 47-82.

Carmona, E.C., A. Veloz Ramírez and A. Cano-Ortiz, 2010. Contribution to the biogeography of the Hispaniola (Dominican Republic, Haiti). *Acta Botanica Gallica* 157 (4), 581-91.

Casal, M.L., P.F. Jezyk, J.M. Greek, M.H. Goldschmidt and D.F. Patterson, 1997. X-linked ectodermal dysplasia in the dog. *Journal of Heredity* 88, 513-7.

Casal, M.L., J.L. Scheidt, J.L. Rhodes, P.S. Henthorn and P. Werner, 2005. Mutation identification in a canine model of X-linked ectodermal dysplasia. *Mammalian Genome* 16 (7), 524-31.

Caughley, G., 1966. Mortality patterns in mammals. *Ecology* 47, 906-18.

Chaix, L., 2000. A preboreal dog from the northern Alps Savoie, France, in S.J. Crockford (ed), *Dogs Through Time. Proceedings of the ICAZ Symposium on the History of the Domestic Dog*. London: BAR International Series 889, 49-59.

Chiew, F., 2014. Poshumane ethics with Cary Wolfe and Karen Barad: animal compassion as trans-species entanglement. *Theory, Culture & Society* 31 (4), 51-69.

Child, A.M., 1995. Towards an understanding of the microbial decomposition of archaeological bone in the burial environment. *Journal of Archaeological Science* 22, 165-74.

Chinique de Armas, Y., W.M. Buhay, R. Rodríguez Suárez, S. Bestel, D.G. Smith, S.D. Mowat and M. Roksandic, 2015. Starch analysis and isotopic evidence of consumption of cultigens among fisher-gatherers in Cuba: the archaeological site of Canímar Abajo, Matanzas. *Journal of Archaeological Science* 58, 121-32.

Chinique de Armas, Y., M. Roksandic, R. Rodríguez Suárez, D. G. Smith, and W.M. Buhay. 2016. Isotopic evidence of variations in subsistence strategies and food consumption patterns among "fishergatherer" populations of western Cuba.", in I. Roksandic (ed), *Cuban Archaeology in the Caribbean*. Gainesville: University Press of Florida, 125-46.

Chisholm, B.S., D.E. Nelson and H.P. Schwarcz, 1982. Stable carbon as ameasre of marine versus terrestrial protein in ancient diets. *Science* 216, 1131-2.

Christenson, A.J., 2007. *Popol Vuh: the sacred book of the Maya: the great classic of American spirituality, translated from the original Maya text*. Norman: University of Oklahoma Press.

Chrószcz, A., M. Janeczek, V. Onar, P. Staniorowski and N. Pospieszny, 2007. The shoulder height estimation in dogs based on the internal dimension of the cranial cavity using mathematical formula. *Anatomy, Histology and Embryology* 36: 269-271.

Clark, G., 1997a. Osteology of the Kuri Maori: the dog of New Zealand. *Journal of Archaeological Science* 24, 113-26.

Clark, G., 1997b. Anthropogenic factors and prehistoric dog morphology: a case study from Polynesia. *Archaeology in Oceania* 32, 124-30

Clark, K.M. 1995. The later prehistoric and protohistoric dog: the emergence of canine diversity. *Archaeozoologia* 7 (2), 9-32.

Clerc, E., 1968. Sites précolombiens de la côte nord-est de la Grande Terre de Guadeloupe, in *Proceedings of the International Congress for the Study of Pre-colonial Cultures in the Lesser Antilles.* Barbados: Barbados Museum, 47-59.

Clutton-Brock, J., 1994. The unnatural world: behavioural aspects of humans and animals in the process of domestication, in A. Manning and J. Serpell (eds), *Animals and Human Society: Changing Perspectives*. London: Routledge, 23-35.

Clutton-Brock, J., 1995. Origins of the dog: domestication and early history, in J. Serpell (ed), *The Domestic Dog: Its Evolution, Behaviour and Interactions with People.* Cambridge: Cambridge University Press, 8-20.

Clutton-Brock, J., and N. Noe-Nygaard, 1990. New osteological evidence on Mesolithic dogs: Companions to hunters and fishers at Star Carr, Seamer Carr and Kongemose. *Journal of Archaeological Science* 17 (6), 643-53.

Clutton-Brock, T.H., F.E. Guinness, and S.D. Albon, 1982. *Red deer: behaviour and ecology of two sexes.* Chicago: University of Chicago Press.

Collins, M.J., C.M. Nielsen-Marsh, J. Hiller, C.I. Smith, J.P. Roberts, R.V. Prigodich, T.J. Wess, J. Csapò, A.R. Millard and G. Turner-Walker, 2002. The survival of organic matter in bone: a review. *Archaeometry* 44 (3), 382-94.

Colonese, A.C., G. Zanchetta, A.E. Fallick, F. Martini, G. Manganelli and L.V. Domenico, 2007. Stable isotope composition of late glacial land snails from Grotta del Romito (southern Italy): palaeoclimatic implications. *Palaeogeography, Palaeoclimatology, Palaeoecology* 254, 550-60.

Columbus, C., 1989 [1492], in O. Dunn and J.E. Kelley (eds), *The Diario of Christopher Columbus's First Voyage to America, 1492-1493.* Norman: University of Oklahoma Press.

Concannon, P.W., 2011. Reproductive cycles of the domestic bitch. *Animal Reproduction Science* 123 (3-4), 200-10.

Cormier, L.A., 2003. *Kinship with monkeys: the Guajá foragers of eastern Amazonia*. New York: Columbia University Press.

Cornwall, I.W., 1974. *Bones for the archaeologist.* London: J.M. Dent & Sons.

Costamagno, S., 2003. Exploitation de la grande faune au Magdalenien dans le sudde la France, in S. Costamagno and V. Laroulandie, V. (eds), *Mode de vie au Magdalenien: les Apports de l'Archeozoologie*. Oxford: BAR International Series, 73-88.

Costamagno, S., L. Meignen, C. Beauval, B. Vandermeersch and B. Maureille, 2006. Les Pradelles (Marillac-le-Franc, France): a Mousterian reindeer hunting camp? *Journal of Anthropology and Archaeology* 25, 466-84.

Craig, H., 1953. The geochemistry of the stable carbon isotopes. *Geochimica et Cosmochimica, Acta* 3, 53-92.

Crespo, E., 1991. Informe preliminary sobre los enterramientoss humanos en el yacimiento de Punta Candelero, Puerto Rico., in E.N. Fisher and J.B. Haviser (eds), *Proceedings of the thirteenth congress of the International Association for Caribbean Archaeology*. Reports of the Archaeological and Anthropological Institute of the Netherlands Antilles, 840-53.

Crocker, J.C., 1985. *Vital souls: Bororo cosmology, natural symbolism, and shamanism.* Tucson: University of Arizona Press.

Crocker, W., and J. Crocker, 1994. *The Canela: bonding through kinship, ritual, and sex.* Fort Worth: Harcourt Brace.

Crosby, A.W., 1972. *The Columbian exchange: biological and cultural consequences of 1492*. Westport: Greenwood Press.

Curet, L.A., 2003. Issues on the diversity and emergence of middle-range societies of the ancient Caribbean: a critique. *Journal of Archaeological Research* 11 (1), 1-42.

Davidson, D., 2001. *Subjective, intersubjective, objective*. Oxford: Oxford University Press.

Davis, S.J.M., 1987. *The archaeology of animals*. London: B.T. Batsford.

Daza Pera, A., 2017. Preliminary studies of late prehistoric dog (*Canis lups f. Familiaris* Linnaeus, 1758) remains from the Iberian peninsula: osteometric and 2D geometric morphometric approaches. *Papers from the Institute of Archaeology* 27 (1), 1-21.

De Goeje, C.H., 1928. *The Arawak language of Guiana*. Amsterdam: Uitgave van der Koninklijke Akademie von Wetenschappen te Amsterdam.

De la Garza, M., 2014. El carácter sagrado del *xoloitzcuintli* entre los nahuas y los mayas. *Arqueología Mexicana* 125, 58-63.

Deloria, V., Jr., 1973. *God is red*. Golden: Fulcrum Publishing.

Delpuech A., Hofman C.L., Hoogland M.L.P. 2002. Premiers horticulteurs amerindiens dans l'archipel guadeloupeen: Morel I (le Moule) et la question Huecan/Cedrosan Saladoide, in A. Delpuech, J.P. Giraud and A. Hesse (eds), *Archeologie Precolombienne et Coloniale des Caraibes :*

Actes du 123e Congres National des Societes Historiques et Scientifiques, Antilles-Guyane, 1998. Paris: Editions du CTHS, 127-39.

DeNiro, M.J. and S. Epstein, 1978. Influence of diet on the distribution of carbon isotopes in animals. *Geochimica et Cosmochimica Acta* 42, 495-506.

DeNiro, M.J. and S. Epstein, 1980. Influence of diet on the distribution of nitrogen isotopes in animals. *Geochimica et Cosmochimica Acta* 45, 341-51.

Denys, C., 2002. Taphonomy and experimentation. *Archaeometry* 44, 469-84.

Descola, P., 1986. *La nature domestique: symbolisme et praxis dans l'écologie des Achuar.* Paris: Maison des Sciences de L'Homme.

Descola, P., 1994. *In the society of nature: A native ecology in Amazonia*. Cambridge: Cambridge University Press.

Descola, P., 1998. Estrutura ou sentimento: a relação com o animal na Amazônia. *Mana* 4, 23-45.

Descola, P., 2013. *Beyond nature and culture*. Chicago: University of Chicago Press.

Dickin, A.P., 1995. *Radiogenic isotope geology*. New York: Cambridge University Press.

DiNovelli-Lang, D., 2013. The return of the animal: poshumanism, indigeneity, and anthropology. *Environment and Society: Advances in Research* 4, 137-56.

Discamps, E. and S. Costamango, 2015. Improving mortality profile analysis in zooarchaeology: a revised zoning for ternary diagrams. *Journal of Archaeological Science* 58, 62-76.

Domınguez-Rodrigo, M., S. de Juana, A.B. Galan and M. Rodríguez, 2009.´A new protocol to differentiate trampling marks from butchery cut marks. *Journal of Archaeological Science* 36, 2643-54.

Domínguez-Rodrigo, M., P. Saladie, I. Cáceres, R. Huguet, J. Yravedra, A. Rodríguez-Hidalgo, P. Martin, A. Pineda, J. Marín, C. Gené, J. Aramendi and L. Cobo-Sánchez, 2017. Use and abuse of cut mark analyses: the Rorschach effect. *Journal of Archaeological Science* 86, 14-23.

Donovan, S.K. and T.A. Jackson, 1994. *Caribbean geology: an introduction.* Kingston: University of the West Indies Publishers'Association.

Drewett, P.L., 1991. *Prehistoric Barbados*. London: Institute of Archaeology and Archetype Publications.

Drewett, P.L., 2000. *Prehistoric settlements in the Caribbean: fieldwork in Barbados, Tortola and the Cayman Islands*. London: Archetype Publications.

Drewett, P.L., 2004. Post-Saladoid society on Barbados, in A. Delpuech and C.L. Hofman (eds), *Late Ceramic Age Societies in the Eastern Caribbean*. British Archaeological Reports, International Series 127. Oxford: Archaeopress, 215-230.

Drögemüller, C., E.K. Karlsson, M.K. Hytönen, M. Perloski, G. Dolf, K. Sainio, H. Lohi, K. Lindblad-Toh and T. Leeb, 2008. A mutation in hairless dogs implicates *FOXI3* in ectodermal development. *Science* 321, 1462.

Druzhkova, A.S., O. Thalmann, V.A. Trifonov, J.A. Leonard, N.V. Vorobieve, *et al.*, 2013. Ancient DNA analysis affirms the canid from Altai as a primitive dog. *PLOS One* 8, e57754.

Ducos, P., 1978. “Domestication” defined and methodological approaches to its recognition in faunal assemblages, in R.H. Meadow and M.A. Zeder (eds), *Approaches to Faunal Analysis in the Middle East.* Peabody Museum Bulletin 2. Cambridge: Harvard University Press, 49-52

Dumont, J. and M. Hurlich, 1981. Protein, protein, what is done in thy name? *Working Papers on South American Indians* 3, 19-23.

Durand J.F. and H. Petitjean-Roget, 1991. A propos d’un collier funeraire, Morel: Guadeloupe, les Huecoides sont-ils un mythe?, in *Compte rendu des communications du douzieme Congres de l’Association Internationale d’Archéologie de la Caraibe*, *Cayenne, juillet-aout 1987*, 53-72.

Edwards, P.C.E, 2015. Natufian interactions along the Jordan Valley. *Palestine Exploration Quarterly* 147 (4), 272-82.

Egi, N., 2001. Body mass estimates in extinct mammals from limb bone dimensions: the case of North American hyaenodontids. *Palaeontology* 44 (3), 497-528.

Ehleringer, J.R. and T.A. Cooper, 1988. Correlations between carbon isotope ratio and microhabitat in desert plants. *Oecologia* 76, 562-6.

Erikson, P., 2000. The social significance of pet-keeping among Amazonian Indians, in P. Poberseck and J. Serpell (eds), *Companion Animals and Us*. Cambridge: Cambridge University Press, 7-26.

Fahquhar, G.D., S. von Caemmerer and J.A. Berry, 1980. A biochemical model of photosynthetic CO_2 assimilation in leaves of C_3 plants. *Planta* 149, 78-90.

Farr, S., 1996. *Unpublished report on the results of stable isotope analysis of human remains from Bloody Point, St Kitts.* Report on file. St. Kitts: St. Christopher National Trust.

Fernandez, P., J.L. Guadelli and P. Fosse, 2006. Applying dynamics and comparing life tables for Pleistocene Equidae in anthropic (Bau de l'Aubesier, Combe-Grenal) and carnivore (Fouvent) contexts with modern feral horse populations (Akagera, Pryor Mountain). *Journal of Archaeological Science* 33, 176-84.

Fernandez, R., M.J. Nadeau and P.M. Grootes, 2012. Macronutrient-based model for dietary carbon routing in bone collagen and bioapatite. *Archaeological and Anthropological Science* 4, 291-301.

Fischer, A., J. Olsen, M.P. Richards, J. Heinmeier, Á.E. Sveinbjörnsdótter and P. Bennike, 2007. Coast-inland mobility and diet in the Danish Mesolithic and Neolithic: evidence from stable isotope values of humans and dogs. *Journal of Archaeological Science* 34 (12), 2125-50.

Fitzpatrick, S., 2011. Verification of Archaic Age occupation on Barbados, southern Lesser Antilles. *Radiocarbon* 53 (4), 595-604.

Flannery, K.V., 1966. The vertebrate fauna and hunting patterns, in S. MacNeish (ed), *Environment and Subsistence: Tehuacan Archaeological-Botanical Project,* vol. 1, 132-77.

Flannery, K.V., 1967. Vertebrate fauna and hunting patterns, in D.S. Byers (ed), *The Prehistory of the Tehuacan Valley*. Austin: University of Texas Press, 132-77.

Fock, N., 1963. *WaiWai: Religion and Society of an Amazonian Tribe*. Copenhagen: The National Museum.

Forest, V., 1997. Données biologiques et données zootechniques anciennes. Essai de mise en equivalence. *Revue de Médicine Vétérinaire* 148 (12), 951- 58.

Freedman, A.H. and R.K. Wayne, 2017. Deciphering the origin of dogs: from fossils to genomes. *Annual Review of Animal Biosciences* 5, 281-307.

Froehle, A.W., C.M. Kellner and M.J. Schoeninger, 2010. FOCUS: effects of diet and protein source on carbon stable isotope ratios in collagen: follow up to Warinner and Tuross (2009). *Journal of Archaeological Science* 37, 2662-70.

Gabriel, M., 2015. *Fields of sense: a new realist ontology*. Edinburgh: Edinburgh University Press.

Geiger, M. and S. Haussman, 2016. Cranial suture closure in domestic dog breeds and its relationship to skull morphology. *The Anatomical Record* 299, 412-20.

Geiger, M., G. Karine, F. Willmitzer and M.R. Sánchez-Villagra, 2016. Unaltered sequence of dental, skeletal, and sexual maturity in domestic dogs compared to the wolf. *Zoological Letters* 2 (16). DOI: 10.1186/s40851-016-0055-2.

Gemonpré, M., M. Lázničková-Galetova and M.V. Sablin, 2012. Palaeolithic dog skulls from the Gravettian Předmostí site, the Czech Republic. *Journal of Archaeological Science* 39, 184-202.

Gemonpré, M., M.V. Sablin, R.E. Stevens, R.E.M. Hedges, M. Hofreiter and V. Després, 2009. Fossil dogs and wolves from Palaeolithic sites in Belgium, the Ukraine and Russia: osteometry, ancient DNA and stable isotopes. *Journal of Archaeological Science* 36, 473-90.

Gifford, D.P., 1981. Taphonomy and paleoecology: a critical review of archaeology's sister disciplines, in M.B. Schiffer (ed), *Advances in Archaeological Method and Theory*, vol. 4. New York: Academic Press, 365-438.

Giovas, C.M., G.D. Kamenov, S.M. Fitzpatrick and J. Krigbaum, 2016. Sr and Pb isotopic investigation of mammal introductions: pre-colonial zoogeographic records from the Lesser Antilles, West Indies. *Journal of Archaeological Science* 69, 39-53.

Goepfert, N., 2012. New zooarchaeological and funerary perspectives on Mochica culture (a.d. 100-800), Peru. *Journal of Field Archaeology* 37 (2), 104-20.

Grouard, S., 2010. Caribbean archaeozoology, in G. Mengoni Goñalons, J. Arroyo-Cabrales, O.J. Polaco and F.J. Aguilar (eds), *Estado Actual de la Arqueozoología Latinoamerica / Current Advances in Latin-American Archaezoology*. Mexico City: Instituto Nacional de Antropología e Historia, Consejo Nacional para la Ciencia y la Tecnología, International Council for Archaeozoology, Universidad de Buenos Aires, 133-50.

Grouard, S., S. Perdikaris and K. Debue, 2013. Dog burials associated with human burials in the West Indies during the early pre-colonial Ceramic Age (500 BC-600 AD). *Anthropozoologica* 48 (2), 447-65.

Gomes, D.M.C., 2001. Santarém: symbolism and power in the tropical forest, in C. McEwan, C. Barreto and E. Neves (eds), *The Unknown Amazon: Culture and Nature in Ancient Brazil*. London: The British Museum Press, 134-55.

Gomes, D.M.C., 2002. *Cerâmica arqueológica da Amazônia: vasilhas da coleção Tapajônica MAE-USP*. São Paulo: Edusp.

Gomes, D.M.C., 2007. The diversity of social forms in Pre-Colonial Amazonia. *Revista de Arqueologia Americana* 25, 189-225.

Gomes, D.M.C., 2010. Os contextos e os significados da arte cerâmica dos Tapajó, in E. Pereira, V.L.C. Guapindala (eds), *Arqueologia amazônica.* Belém: Museu Paraense Emílio Goeldi, 213-34.

Gomes, D.M.C., 2012. O perspectivismo ameríndio e a ideia de uma estética americana. *Boletim do Museu Paraense Emílio Goeldi. Ciências Humanas* 7 (1), 133-59.

Grouard S., 2001. *Subsistance, systèmes techniques et gestion territoriale en milieu insulaire antillais précolombien - exploitation des vertébrés et des crustacés aux époques Saladoïdes et Troumassoïdes de Guadeloupe (400 av. J.-C. à 1 500 ap. J.-C.).* Paris (unpublished Ph.D. thesis Université de Nanterre).

Grouard, S., 2004. Variation des strategies de subsistence des Precolombiens a Hope Estate, Saint Martin (F.W.I.), d'apres l'analyse des restes des petits vertebres, in J.P. Brugal and J. Desse (eds), *XXIVemes Rencontres Internationales d'Archéologie et d'Histoire d'Antibes* - *«Petits animaux et sociétés humaines: du complément alimentaire aux ressources utilitaires», Rencontres d'Antibes 23-24-25 October 2003*, 451-67.

Grouard S., S. Perdikaris and K. Debue, 2013. Dog burials associated with human burials in the West Indies during the early pre-colonial Ceramic Age (500 BC-600 AD). *Anthropozoologica* 48 (2), 447-65.

Guedes Milheira, R., D.M. Loponte, C. García Esponda, A. Acosta and P. Ulguim, 2016. The first record of a pre-colonial domestic dog (*Canis lupus familiaris*) in Brazil. *International Journal of Osteoarchaeology* 27 (3), 488-94.

Guiry, E.J., 2012. Dogs as analogs in stable isotope-based human paleodietary reconstructions: A review and considerations for future use. *Journal Archaeological Method* 19, 351-76.

Guiry, E.J., J.C. Hepburn and M.P. Richards, 2016. High resolution serial sampling for nitrogen stable isotope analysis of archaeological animal teeth. *Journal of Archaeological Science* 69, 21-8.

Guppy, N., 1954. A dog's life among the Waiwais. *Natural History*, March issue.

Hackenberger, S., 1991. An abstract of archaeological investigations by the Barbados Museum, 1986, in L.S. Robinson (ed), *Proceedings of the twelfth International Congress for Caribbean Archaeology*. Martinique, 163-74.

Haklay, G. and A. Gopher, 2015. A new look at shelter 131/51 in the Natufian site of Eynan (Ain Mallaha), Israel. *PLOS One* 10 (7), e0130121. DOI: 10.1371/journal.pone.0130121.

Halbmayer, E., 2012a. Amerindian mereology: Animism, analogy, and the multiverse. *Indiana* 29, 103-25.

Halbmayer, E., 2012b. Debating animism, perspectivism and the construction of ontologies. *Indiana* 29, 9-23.

Hale, E.B., 1969. Domestication and the evolution of behaviour, in E.S.E. Hafez (ed), *The Behaviour of Domestic Animals*, 2nd edition. London: Bailliere, Tindall, and Cassell, 22-42.

Halstead, P., 1998. Mortality models and milking: problems of uniformitarism, optimality and equifinality reconsidered. *Anthropozoologica* 27, 3-20.

Hames, R., 1979. A comparison of the efficiencies of the shotgun and the bow in Neotropical forest hunting. *Human Ecology* 7, 219-52.

Hansen, L.J., 1987. *Indo-European views of death and the afterlife as determined from archaeological, mythological, and linguistic sources*. Los Angeles (unpublished Ph.D. thesis University of California).

Hansford, J., J.M. Nuñez-Miño, R.P. Young, S. Brace, J.L. Brocca and S.T. Turvey, 2012. Taxonomy-testing and the 'Goldilocks Hypothesis': morphometric analysis of species diversity in living and extinct Hispaniolan hutias. *Systematics and Biodiversity* 10, 491-507.

Harcourt, R.A., 1974. The dog in prehistoric and early historic Britain. *Journal of Archaeological Science* 1, 151-75.

Hare, P.E., 1980. Organic geochemistry of bones, and its relation to the survival of bone in the natural environment, in A.K. Behrensmeyer and A.P. Hill (eds), *Fossils in the Making*. Chicago: University of Chicago Press, 208-19.

Hare, P.E., M.I. Fogela, T.W. Stafford Jr., A.D. Mitchell and T.C. Hoering, 1991. The isotopic composition of carbon and nitrogen in individual amino acids isolated from modern and fossil proteins. *Journal of Archaeological Science* 18, 277-92.

Hare, W.C.D., 1959. Radiographic anatomy of the canine pectoral limb. *Journal of the American Veterinary Medical Association* 135, 264-271, 305-310.

Hare, W.C.D., 1960. The age at which epiphyseal union takes place in the limb bones of the dog. *Wien Tierarztl Monatsschr, Festschrift Schreiber*, 224-43.

Hawthorne, A.J, D. Booles, P.A. Nugent, G. Gettinby and J. Wilkinson, 2004. Body-weight changes during growth in puppies of different breeds. *Journal of Nutrition* 134, 2027-30.

Heckenberger, M.J., 2002. Rethinking the Arawakan diaspora: hierarchy, regionality, and the Amazonian formative, in J.D. Hill and F. Santos-Granero (eds), *Comparative Arawakan Histories: Rethinking Language Family and Culture Area in Amazonia*. Urbana: University of Illinois Press, 99-122.

Heckenberger, M.J. and J.B. Petersen, 1995. Concentric circular village patterns in the Caribbean: comparisons from Amazonia. *Proceedings of the International Congress for Caribbean Archaeology* 16 (2), 379-390.

Hedges, R.E.M., 2002. Bone diagenesis: an overview of processes. *Archaeometry* 44, 319-28.

Hedges, R.E.M., J.G. Clement, D.L. Thomas and T.C. O'Connell, 2007. Collagen turnover in the adult femoral mid-shaft: modelled from anthropogenic radiocarbon tracer measurements. *American Journal of Physical Anthropology* 133, 808-16.

Heinen, H.D., 1972. *Adaptive changes in a tribal economy: a case study of the Winikina-Warao*. Los Angeles (unpublished Ph.D. thesis University of California Los Angeles).

Helms, M.W., 2004. Tangible materiality and cosmological others in the development of sedentism, in E. DeMarrais, C. Gosden and C. Renfrew (eds), *Rethinking Materiality: The Engagement of Mind with* *the Material World*. McDonald Institute Monographs. Cambridge: McDonald Institute for Archaeological Research. University of Cambridge, 117-27.

Henfrey, T.B., 2002. *Ethnoecology, resource use, conservation and development in a Wapishana community in the South Rupununi, Guyana.* Kent (unpublished Ph.D. thesis University of Kent).

Henley, P., 1982. *Tradition and change on the Amazonian frontier.* New Haven: Yale University Press.

Herrera Malatesta, E.N., 2018. *Una isla, dos mundos: studio arquelógico sobre el paisaje indígena de Haytí y su transformación al paisaje colonial de La Española (1200-1550).* Sidestone Press: Leiden.

Higham, C.F.W., A. Kijngam and B.F.J. Manly, 1980. An analysis of prehistoric canid remains from Thailand. *Journal of Archaeological Science* 7, 149-65.

Hill, E., 2011. Animals as agents: Hunting ritual and relational ontologies in prehistoric Alaska and Chukotka. Cambridge Archaeological Journal 21, 407-26.

Hill, E., 2013. Archaeology and animal persons: Towards a prehistory of human-animal relations. *Environment and Society: Advances in Research* 4, 117-36.

Hill, J.D., 1983. *Wakuenai society: A processual-structural analysis of indigenous cultural life in the Upper Rio Negro region of Venezuela*. Bloomington (unpublished Ph.D. thesis Indiana University).

Hill, M.E., M.G. Hill and C.C. Widga, 2008. Late Quaternary bison diminution on the Great Plains of North America: evaluating the role of human hunting versus climate change. *Quaternary Science Review* 27, 1752-71.

Hillson, S., 1997. *Dental Anthropology*. Cambridge: Cambridge University Press.

Hodder, I., 2011a. Human-thing entanglement: towards an integrated archaeological perspective. *The Journal of the Royal Anthropological Institute* 17 (1), 154-77.

Hodder, I., 2011b. Wheels of time: some aspects of Entanglement Theory and the Secondary Products Revolution. *Journal of World Prehistory* 24, 175-87.

Hofman, C.L., A. Delpuech and M.L.P. Hoogland, 2014. *Espaces amérindiens. Archéologie en Grande-Terre de Guadeloupe.* Le Moule: musée départemental Edgar Clerc, catalogue de l'exposition.

Hofman, C.L. and M.L.P. Hoogland, 2015. Investigaciones arquelógicos en los sitios El Flaco (Loma de Guayacanes) y La Luperona (UNIJICA). Informe preliminar. *Boletín del Museo del Hombre Dominicano* 46 (42), 61-74.

Hofman, C.L, M. Hoogland, A. Delpuech, T. Hamburg, S. Knippenberg, Y. Lammers-Keijsers, J. Mol, D. Nieweg, M. Nokkert, E. Pélissier and T. Romon, 1999. *Guadeloupe, Le Moule, site précolombien de Morel: fouilles archéologiques de 1999*. Basse Terre: Guadeloupe.

Hofman, C.L., M.L.P Hoogland, H.L. Mickleburgh, J.E. Laffoon, D.A. Weston and M.H. Field, 2012. Life and death at precolumbian Lavoutte, Saint Lucia, Lesser Antilles. *Journal of Field Archaeology* 37 (3), 209-25.

Hofman, C.L., M.L.P. Hoogland, D. Weston, F. van der Leden, J. Pagan Jiménez, J.E. Laffoon and H. Schroeder, *in prep. Ancient Mounds*.

Hofman, C., A. Mol, M. Hoogland and R. Valcárcel Rojas, 2014. Stage of encounters: migration, mobility and interaction in the pre-colonial and early colonial Caribbean. *World Archaeology* 46 (4), 590-609.

Hofman, C.L., J. Ulloa Hung, E. Herrera Malatesta, J.S. Sean, T. Sonnemann and M. Hoogland, 2018. Indigenous Caribbean perspectives: archaeologies and legacies of the first colonised region in the New World. *Antiquity* 92 (361), 200-17.

Hogue, H.S., 2003. Corn dogs and hush puppies: diet and domestication at two prehistoric farmsteads in Okitibbeha County, Mississippi. *Southeastern Archaeology* 22, 185-95.

Hoogland, M.L.P. and C.L. Hofman, 2013. From corpse taphonomy to mortuary behaviour in the Caribbean: a case study from the Lesser Antilles, in W.F. Keegan, C.L. Hofman and R. Rodríguez Ramos (eds), *The Oxford Handbook of Caribbean Archaeology*. Oxford: Oxford University Press, 452-69.

Hoogland, M.L.P., C.L. Hofman, and R.G.A.M. Panhuysen, 2010. Interisland dynamics: evidence for human mobility at the site of Anse à la Gourde, Guadeloupe, in S.M. Fitzpatrick and A.H. Ross (eds), *Island Shores, Distant Pasts: Archaeological and Biological Approaches to the Pre- Columbian Settlement of the Caribbean*. Gainesville: University Press of Florida, 148-62.

Hopkins, J.B. III and J.M. Ferguson, 2012. Estimating the diets of animals using stable isotopes and a comprehensive Bayesian mixing model. *PLOS One* 7 (1), e28478.

Howard, C.V., 2001. *Wrought identities: The Waiwai expeditions in search of the "unseen tribes" of northern Amazonia*. Chicago (unpublished Ph.D. thesis University of Chicago).

Ingold, T., 1991. Becoming persons: consciousness and sociality in human evolution. *Cultural Dynamics* 4 (3), 355-78.

Ingold, T., 1994. Humanity and animality, in T. Ingold (ed), *Companion Encyclopedia of Anthropology: Humanity, Culture and Social Life*. London: Routledge, 14-32.

Ingold, T., 2000. *The perception of the environment: essays on livelihood, dwelling and skill*. London: Routledge.

Iturralde-Vinent, M.A. and R.D.E. MacPhee, 1999. Paleogeography of the Caribbean region: implications for Cenozoic biogeography. *Bulletin of the American Museum of Natural History* 238, 1-95.

Janeczek, M., 2014. Height at the withers estimation in the horses based on the internal dimension of cranial cavity. *Folia Morphologica* 73 (2), 143-8.

Johnson, D.L. and B.K. Swartz, 1990. Evidence for pre-colonial animal domestication in the New World. *Lambda Alpha Journal* 21, 42-54.

Kalsbeek, N. and J. Richter, 2006. Preservation of burned bones: an investigation of the effects of temperature and pH on hardness. *Studies in Conservation* 51, 123-38.

Kaplan, H. and K. Kopischke, 1992. Resource use, traditional technology, and change among native peoples of Lowland South America, in K.H. Redford and C. Padoch (eds), *Conservation of Neotropical Forests: Working From Traditional Resource Use*. New York: Columbia University Press, 83-107.

Karadimas, D., 2012. Animism and perspectivism: still anthropomorphism? On the problem of perception in the construction of Amerindian ontologies. *Indiana* 29, 25-51.

Katzenberg, M.A., 1989. Stable isotope analysis of archaeological faunal remains from Southern Ontario. *Journal of Archaeological Science* 16 (3), 319-29.

Keegan, W.F. and L.A. Carlson, 2008. *Talking 'Taíno': essays on Caribbean natural history from a native perspective*. Tuscaloosa: University of Alabama Press.

Keegan, W.F. and M.J. DeNiro, 1988. Stable carbon and nitrogen isotope ratios of bone collagen used to study coral-reef and terrestrial components of prehistoric Bahamian diet. *American Antiquity* 53 (2), 320-36.

Keegan, W.F. and C.L. Hofman, 2017. *The Caribbean before Columbus*. Oxford: Oxford University Press.

Kimura, B.K., M.J. LeFebvre, S.D. de France, H.I. Knodel, M.S. Turner, N.S. Fitzsimmons, S.M. Fitzpatrick and C.J. Mulligan, 2016. Origin of the pre-colonial guinea pigs from Caribbean archaeological sites revealed through genetic analysis. *Journal of Archaeological Science: Reports* 5, 442-52.

Klein, R.G., 1978. Stone Age predation on large African bovids. *Journal of Archaeological Science* 5, 195-217.

Klein, R.G., 1981. Stone Age predation on small African bovids. *South African Archaeology* 36, 55-65.

Klein, R.G., 1982. Age (mortality) profiles as a mean of distinguishing hunted species from scavenged ones in Stone Age archaeological sites. *Paleobiology* 8, 151-8.

Knight, J., 2012. The anonymity of the hunt a critique of hunting as sharing. *Current Anthropology* 53 (3), 334-55.

Koch-Grünberg, T., 1923. *Vom Rorroima zum Orinoco*. Vol. 2. Berlin: Dietrich Reimer (Ernest Vohsen).

Kohn, E., 2007. How dogs dream: Amazonian natures and the politics of transspecies engagement. *American Ethnologist* 34, 3-24.

Kohn, E., 2015. Anthropology of ontologies. *Annual Review of Anthropology* 44, 311-27.

Kohn, M.J., 1996. Predicting animal δ^{18}O: Accounting for diet and physiological adaptation. *Geochimica Cosmochimica Acta* 60, 4811-29.

Kohn, M.J. 2010. Carbon isotope compositions of terrestrial C_3 plants as indicators of (paleo)ecology and (paleo)climate. *Proceedings of the National Academy of Sciences* 107 (46), 19691-5.

Kontopoulos, I., P. Nystrom and L. White, 2016. Experimetal taphonomy: post-mortem microstructural modifications in *Sus scrofa domesticus* bone. *Forensic Science International* 266, 320-28.

Koster, J., 2007. *Hunting and subsistence among the Mayangna and Miskito of Nicaragua's Bosawas Biosphere Reserve*. Philadelphia (unpublished Ph.D. thesis Penn State University).

Koster, J., 2009. Hunting dogs in the lowland Neotropics. *Journal of Anthropological Research* 65 (4), 575-610.

Krigbaum, J., S.M. Fitzpatrick and J. Bankaitis, 2013. Human paleodiet at Grand Bay, Carriacou, Lesser Antilles. *The Journal of Island and Coastal Archaeology* 8 (2), 210-27.

Laffoon, J.E., 2012. *Patterns of paleomobility in the ancient Antilles*. Leiden (unpublished Ph.D thesis Leiden University).

Laffoon, J.E., 2016. Human mobility and dietary patterns in precolonial Puerto Rico: Integrating multiple isotope data, in I. Roksandic (ed), *Cuban Archaeology in the Caribbean,* Gainesville: University Press of Florida, 147-67.

Laffoon, J.E., 2017. *Preliminary report on the results of isotope analysis on archaeological specimens from the Dominican Republic (2016-2017).* Internal Report Museo del Hombre Dominicano, Santo Domingo.

Laffoon, J.E., G.R. Davies, M.L.P. Hoogland and C.L. Hofman, 2012. Spatial variation of biologically available strontium isotopes (^{87}Sr/^{86}Sr) in an archipelagic setting: a case study from the Caribbean. *Journal of Archaeological Science* 39, 2371-84.

Laffoon, J. E. and B. de Vos, 2011. Diverse origins, similar diets. An integrated isotopic perspective from Anse à la Gourde, Guadeloupe, in C.L. Hofman and A. van Duijvenbod (eds), *Communities in Contact. Essays in Archaeology, Ethnohistory and Ethnography of the Amerindian Circum-Caribbean*, Leiden: Sidestone Press, 187-203.

Laffoon, J.E., M.L.P. Hoogland, G.R. Davies and C.L. Hofman, 2016a. Human dietary assessment in the Pre-colonial Lesser Antilles: New stable isotope evidence from Lavoutte, Saint Lucia. *Journal of Archaeological Science Reports* 5, 168-80.

Laffoon, J.E., M.L.P. Hoogland, G.R. Davies and C.L. Hofman, 2017. A multi-isotope investigation of human and dog mobility and diet in the pre-colonial Antilles. *Environmental Archaeology*. DOI: 10.1080/14614103.2017.1322831.

Laffoon, J.E., E. Plomp, G.R. Davies, M.L.P. Hoogland and C.L. Hofman, 2015. The movement and exchange of dogs in the prehistoric Caribbean: an isotopic investigation. *International Journal of Osteoarchaeology* 25 (4), 454-65.

Laffoon, J.E., R. Rodríguez Ramos, L. Chanlatte Baik, Y. Narganes Storde, M.R. Rodríguez Lopez, G.R. Davies and C.L. Hofman, 2014. Long-distance exchange in the precolonial circum-Caribbean: a multi-isotope study of animal tooth pendants from Puerto Rico. *Journal of Anthropological Archaeology* 35, 220-33.

Laffoon, J.E., T.F. Sonnemann, M.M. Antczak, and A.Antczak, 2016b. Sourcing non-native mammal remains from Dos Mosquises Island, Venezuela: new multiple isotope evidence. *Anthropological and Archaeological Sciences*, 1-17. DOI: 10.1007/s12520-016-0453-6.

Lammers-Keijsers, Y., 2007. *Tracing traces from present to past: a functional analysis of pre-colonial shell and stone artefacts from Anse à la Gourde and Morel, Guadeloupe*. Leiden: Leiden University Press.

Landt, M.J., 2007. Tooth marks and human consumption: ethnoarchaeological mastication research among foragers of the Central African Republic. *Journal of Archaeological Science* 34 (10), 1629-40.

Larson, G., E.K. Karlsson, A. Perri, M.T. Webster, S.Y.W. Ho, et al., 2012. Rethinking dog domestication by intergrating genetics, archaeology, and biogeography. *PNAS* 109, 8878-83.

Las Casas, Fray Bartolomé de, 1875a. *Historia de las Indias,* vol. 1. Madrid: Miguel Ginesta.

Las Casas, Fray Bartolomé de, 1875b. *Historia de las Indias,* vol. 2. Madrid: Miguel Ginesta.

Las Casas, Fray Bartolomé de, 1909. *Apologética Historia de las Indias*. Nueva Bibliotéca de Autores Españoles 13. Madrid: Bailly Baíllere é Hijos.

Las Casas, Fray Bartolomé de, 1929, in M. Aguilar (ed), *Historia de las* Indias. *Vol. I - III*. Madrid.

Latour, B., 1993. *We have never been modern*. Cambridge: Harvard University Press.

Latta, S., C. Rimmer, A. Keith, J. Wiley, H.A. Raffaele, K. McFarland and E. Fernandez, 2006. *Birds of the Dominican Republic and Haiti.* Princeton: Princeton University Press.

Lawrence, B., 1977. Dogs from the Dominican Republic, *Cuardenos del Cendia*, *Centro Domincano de Investigaciones Antropologicas, Universidad Autonoma de Santo Domingo* 168 (8), 3-19.

Lebreton, L., A.M. Moigne, A. Filoux and C. Perrenoud, 2017. A specific small game exploitation for Lower Palaeolithic beaver (*Castor fiber*) exploitation at the Caune de l'Arago (Pyrénées-Orientales, France). *Journal of Archaeological Science: Reports* 11, 53-8.

LeFebvre, M.J. and S.D. deFrance, 2014. Guinea pigs in the pre-colonial West Indies. *The Journal of Island and Coastal Archaeology* 9 (1), 16-44.

LeFebvre, M.J., S.D. deFrance, G. Kamenov, W. Keegan and J. Krigbaum, 2017. *The zooarchaeology and isotopic ecology of Bahamian hutia* (Geocapromys ingrahami). Presented at the 81st Annual Meeting of the Society for American Archaeology, Vancouver, British Columbia.

Lechevallier, M., R. Meadow and G. Quivron, 1982. Depots d'animaux dans les sépultures néolithiques de Mehrgarh, Pakistan. *Paléorient* 8, 99-106.

Lee-Thorp, J.A., 2008. On isotopes and old bones. *Archaeometry* 50 (6), 925-50.

Lee-Thorp, J.A., J.C. Sealy and N.J. Van der Merwe, 1989. Stable carbon isotope ratio differences between bone collagen and bone apatite, and their relationship to diet, *Journal of Archaeological Science* 16, 585-99.

Legendre, S. and C. Roth, 1988. Correlation of carnassial tooth size and body weight in recent carnivores (Mammalia). *Historical Biology* 1, 85-98.

Leonard, J.A, R.K. Wayne, J. Wheeler, R. Valadez, S. Guillen and C. Vilà, 2002. Ancient DNA evidence for Old World origin of New World dogs. *Science* 298, 1613-6.

Levi-Strauss, C., 1981. *The naked man. Introduction to a science of mythology (mythologiques)* (J. Weightman and D. Weightman, Trans.). London: Jonathan Cape.

Levine, M., 1983. Mortality models and the interpretation of horse population structure, in G. Bailey (ed), *Hunter-gatherer Economy in Prehistory: a European Perspective*. Cambridge: Cambridge University Press, 23-46.

Lewis, J.R., A.M. Reiter, E.A., Mauldin and M.L. Casal, 2010. Dental abnormalities associated with X linked hypohidrotic ectodermal dysplasia in dogs. *Orthodontics* and *Craniofacial Research* 13 (1), 40-7.

Liebenberg, D., 2016. The bird-nester, the jaguar and the fire-theft: a new approach to the culture-nature dimension in Amazonian myth. *Tipití: Journal of the Society for the Anthropology of Lowland South America* 14 (1), 15-28.

Lindberg, C., 2013. The noble and ignoble savage. *Ethnoscripts* 15 (1), 16-32.

Lindbland-Toh, K., C.M. Wade, T.S. Mikkelsen, E.K. Karlsson, D.B. Jaffe, M. Kamal, M. Clamp, J.L. Chang, E.J. Kulbokas and M.C. Zody, 2005. Genome sequence, comparative analysis and haplotype structure of the domestic dog. *Nature* 438, 803-19.

Lindstrøm, T.C., 2012. "I am the walrus": animal identities and merging with animals- exceptional experiences? *Norwegian Archaeological Review* 45, 151-76.

Londoño Sulkin, C.D., 2006. Inhuman beings: morality and perspectivism among Muinane people (Colombian Amazon). *Ethnos* 70 (1), 7-30.

Losey, R.J., V.I. Bzaliiskii, A.R. Lieverse, A. Waters-Rist, K. Faccia and A.W. Weber, 2011. Canids as persons: early Neolithic dog and wolf burials, Cis-Baikal, Siberia. *Journal of Anthropological Archaeology* 30 (2), 174-89.

Lyman, R.L., 1987a. Archaeofaunas and butchery studies: a taphonomic perspective. *Advances in Archaeological Method and Theory* 10, 249-337.

Lyman, R.L., 1987b. On the analysis of vertebrate mortality profiles: sample size, mortality profile, and hunting pressure. *American Antiquity* 52, 125-42.

Lyon, W.S., 2016. The necessity to rethink magic. *Journal for the Study of Religion, Nature and Culture* 10 (2), 208-27.

MacPhee, R.D.E. and C. Flemming, 1999. Requiem æternam: the last five hundred years of mammalian species extinction, in R.D.E. MacPhee (ed), *Extinctions in Near Time: Causes, Contexts, and Consequences*. New York: Kluwer Academic/Plenum, 333-71.

Magaña E., 1987. *Contribuciones al estudio de la mitología y astronomía de los Índios de las Guayanas*. CEDLA Latin American Studies vol. 35. Amsterdam: Foris Publications.

Maher, L.A., J.T. Stock, S. Finney, J.J.N. Heywood, P.T. Miracle and E.B. Banning, 2011. A unique human-fox burial from a pre-Natufian cemetery in the Levant (Jordan). *PLOS One* 6 (1), e15815.

Marom, M. and G. Bar-Oz, 2009. Culling profiles: the indeterminacy of archaeozoological data to survivorship curve modelling of sheep and goat herd maintenance strategies. *Journal of Archaeological Science* 36, 1184-7.

Marshall, F.B., 1986a. Implications of bone modification in a Neolithic faunal assemblage for the study of early hominid butchery and subsistence practices. *Journal of Human Evolution* 15 (8), 661-72.

Marshall, F.B., 1986b. *Aspects of the advent of the pastoral economies in East Africa.* Berkeley (unpublished Ph.D. thesis University of California).

Martínez Villanueva, C., 2015. El manuscrito de Ferrara. *Boletín del Museo del Hombre Domnicano*, Año XLII, 46, 215-26.

Mártir de Anglería, P., 1892. *Fuentes históricos sobre Colon y America, tomo 1 (lo que tocante á estos asuntos en curenta y tres cartas y la perimera década historial*). Madrid: San Francisco de Sales.

Mattioni, M. and R.P. Bullen, 1974. Precolumbian dogs in the Lesser Antilles and Greater Antilles, in *Proceedings of the 5th Congress of the International Association for Caribbean Archaeology, Antigua 1973*, 162-5.

McFarlane, D.A., A. Vale, K. Christenson, J. Lundberg, G. Atilles and S.-E. Lauritzen, 2000. New specimens of Late Quaternary extinct mammals from caves in Sanchez Ramirez Province, Dominican Republic. *Caribbean Journal of Science* 36, 163-6.

Mejía, M., 2006. *Flora de la Española: conocimiento actual y estado de conservación*. Presented at the IX Congreso Latinoamericano de Botánica, 18-25 junio 2006, Santo Domingo, 11-12. Jardín Botánico Nacional Dr Rafael Ma. Moscoso.

Mickleburgh, H.L. and J.R. Pagan-Jimenez, 2012. New insights into the consumption of maize and other food plants in the pre-colonial Caribbean from starch grains trapped in human dental calculus. *Journal of Archaeological Science* 39 (7), 2468-78.

Millard, A., 2001. The deterioration of bone, in D.R. Brothwell and A.M. Pollard (eds), *Handbook of Archaeological Science*. Chichester: Wiley, 637-48.

Minagawa, M. and E. Wada, 1984. Stepwise enrichment of ^{15}N along food chains: further evidence and the relation between δ^{15}N and animal age. *Geochimica et Cosmochimica Acta* 48, 1135-40.

Montás, O., P. José Borrell and F. Moya Pons, 1983. *Arte 'Taíno'*. Santo Domingo: Banco Central de la República Dominicana.

Moravetz, I., 2005. *Imaging adornos: classification and iconography of Saladoid adornos from St. Vincent, West Indies*. Oxford: British Archaeological Reports International Series.

Morbán, F., 1980. Los figurines de arcilla en la prehistoria. *Boletín del Museo del hombre Dominicano IX* (13), 81-114.

Morey, D.F., 2006. Burying key evidence: the social bond between dogs and people. *Journal of Archaeological Science* 33, 158-75.

Morey, D.F. and M.D. Wiant, 1992. Early Holocene domestic dog burials from the North American Midwest. *Current Anthropology* 33, 224-9.

Müldner, G. and M.P. Richards, 2005. Fast or feast: reconstructing diet in later medieval England by stable isotope analysis. *Journal of Archaeological Science* 32, 39-48.

Munro, N.D., 2003. Small game, the Younger Dryas, and the transition to agriculture in the southern Levant. *Mitteilungen der Gesellschaft für Urgeschichte* 12, 47-71.

Murray, M. and M.J. Schoeninger, 1988. Diet, status and complex social structure in Iron Age Europe: some contributions of bone chemistry, in B. Gibson and M. Geselowitz (eds), *Tribe and Polity in Late Prehistoric Europe*. New York: Plenum, 155-76.

Nadasdy, P., 2007. The gift in the animal: the ontology of hunting and human-animal sociality. *American Ethnologist* 34, 25-43.

Newsome, S.D., M.I. Fogel, L. Kelly and C.M. de Rio, 2011. Contributions of direct incorporation from diet and microbial amino acids to protein synthesis in Nile tilapia. *Functional Ecology* 25, 1051-62.

Narganes Storde, Y.M., 1982. *Vertebrate faunal remains from Sorcé, Vieques, Puerto Rico*. Atlanta (unpublished M.A. thesis University of Georgia).

Narganes Storde Y.M., 1985. Restos faunisticos vertebrados de Sorce, Vieques, Puerto Rico, in *Comptes Rendus des Communications du Dixieme Congres International d'Etudes des Civilisations Précolombiennes des Petites Antilles*. Fort-de-France, Martinique, 1983, 251-264.

Navarrete, M. F. de., 1922. *Viajes de Cristóbal Colón*. Viajes Clásicos. Madrid: CALPE.

Newsom L.A., 1995. Mangroves and root crops: the archaeobotanical record from En Bas Saline, Haiti, in G. Richard (ed), *Proceedings of the Sixteenth International Congress for Caribbean Archaeology*. Guadeloupe, 52-66.

Newsom, L.A. and E.S. Wing, 2004. *On land and sea: Native American uses of biological resources in the West Indies*. Tuscaloosa: University of Alabama Press.

Nicholson, R.A., 2001. Taphonomic investigations, in D.R. Brothwell and A.M. Pollard (eds), *Handbook of Archaeological Science*. Chichester: Wiley, 179-90.

Noe-Nygaard, N., 1988. δ^{13}C-values of dog bone reveal the nature of changes in man's food resources at the Mesolithic-Neolithic transition, Denmark. *Chemical Geology* 73 (1), 87-96.

Noe-Nygaard, N., 1989. Man-made trace fossils in bones. *Human Evolution* 4 (6), 461-91.

Norr, L., 2002. Bone isotopic analysis and prehistoric diet at the Tutu site, in E. Righter (ed), *The Tutu Archeological Village Site: A Multidisciplinary Case Study in Human Adaptation*. London: Routledge, 263-73.

O'Connor, T.P., 1997. Working at relationships: another look at animal domestication. *Antiquity* 71, 149-56.

O'Day, S.J. and W.F. Keegan, 2001. Expedient shell tools from the northern West Indies. *Latin American Antiquity* 12 (3), 274-90.

Ogden, L.A., B. Hall and K. Tanita, 2013. Animals, plants, people and things: a review of multispecies ethnography. *Environment and Society: Advances in Research* 4, 5-24.

O'Leary, M., 1981. Carbon isotope fractionation in plants. *Phytochemistry* 20, 553-67.

O'Leary, M.H., 1988. Carbon isotopes in photosynthesis. *BioScience* 38 (5), 328-36.

Oliver, J.R., 1997. The 'Taíno' Cosmos, in S. Wilson (ed), *Indigenous People of the Caribbean.* Gainesville: University Press of Florida, 140-53.

Oliver, J.R., 1998. *El centro ceremonial de Caguana, Puerto Rico: Simbolismo iconográfico, cosmovisión y el coderío caciquil 'Taíno' de Boriquén*. British Archaeological Reports, International Series No. 727. Oxford: Archaeopress.

Oliver, J.R., 1999. The ‘La Hueca problem’ in Puerto Rico and the Caribbean: old problems, new perspectives, possible solutions, in C.L. Hofman and M.L.P. Hoogland (eds), *Archaeological Investigations on St. Martin (Lesser Antilles): The Sites of Norman Estate, Anse des Pères and Hope Estate with a contribution to the ‘La Hueca problem*. Leiden: Leiden University Press, 253-97.

Oliver, J.R., 2008. El universe material y spiritual de los ‘Taíno’s, in J.R. Oliver, C. McEwan and A. Casas Gilberga (eds), *El Caribe Precolombino: Fray Ramón Pané y el Universe ‘Taíno’*. Madrid: Studia Humanitatis.

Olsen, S.J. 1976. The dogs of Awatovi. *American Antiquity* 41, 102- 106.

Olsen, S.J., 1985. *Origins of the domestic dog: the fossil record*. Tucson: University of Arizona Press.

Olsen, S.L. and P. Shipman, 1988. Surface modification on bone: trampling versus butchery. *Journal of Archaeological Science* 15, 535-53.

Onar, V, M. Janeczek, G. Pazvant, N. Gezer Ince, H. Alpak, A. Armutak, A. Chrószcz and Z. Kiziltan, 2015. Estimating body weight of Byzantine dogs from Theodosius Harbour at Yenikapı, Istanbul. *Kafkas Universitesi Vertiner Fakultesi Dergisi* 21 (1), 55-9.

Ortega, R.F., D.G. Calvahe, J.B. Gonzalez Tendero and J.C. Huartt, 2006. Sobre la presencia del perro en el legado rupestre de los aborigenes de las Antilles, in *Ponencia presentada en la VIII Conferencia Internacional Antropología. Instituto Cubano de Antropología*. La Habana.

Overing, J., 1985. There is no end of evil: the guilty innocents and their fallible god, in D. Parkin (ed), *The Anthropology of Evil*. London: Basil Blackwell, 244-78.

Overing, J., 1986. Images of cannibalism, death and domination in a ‘non-violent’society. *Journal de la Société des Américanistesi* 72, 133-56.

Oviedo y Valdés, G. H. de, 1946. *Sumario de la Natural Historia de las Indias*. Bibliotéca de Autores Españoles desde la Formación de Lenguaje hasta Nuestro Dias, vol. 22. Madrid: Real Academía Española.

Oviedo y Valdés, G.H. de, 1959. *Historia General y Natural de las Indias* 2. Bibliotéca de Autores Españoles desde la Formación de Lenguaje hasta Nuestro Dias, vol. 118. Madrid: Real Academía Española.

Ovodov, N.D., S.J. Crockford, Y.V. Kuzmin, T.F.G. Higham, G.W.L. Hodgins, et al. 2011. A 33,000-year-old incipient dog from the Altai mountains of Siberia: evidence of the earliest domestication disrupted by the last glacial maximum. *PLOS One* 6, e22821.

Pagden, A. 1992. *Bartolomé de Las Casas: a short account of the destruction of the Indies*. New York: Penguin Group.

Pagán-Jiménez, J. R. and E. Carlson, 2013. New Insights into Pre-colonial Plant Use from Excavations at two Late-Ostionoid Sites in Eastern Puerto Rico, in *Proceedings of the 24th Congress of the International Association for Caribbean Archaeology.* Martinique.

Pagán Perdomo, D., 1978. *Nuevas pictografías en la isla de Santo Domingo. Las Cuevas de Borbon.* Santo Domingo: Museo del Hombre Dominicano.

Pané, F.R., 1999. *An account of the antiquities of the Indians* (S.C. Griswold, Trans.). Durham: Duke University Press.

Patte, M.F., 2002. The Arawak languages, in E.B. Carlin and J. Arends (eds), *Atlas of the Languages of Suriname*. Leiden: KITLV Press, 83-114.

Payne, S., 1973. Kill-off patterns in sheep and goats: the mandibles from Asvan Kale. *Anatolian Studies* 23, 282-303.

Pearce, J. and R. Luff, 1994. The taphonomy of cooked bone, in R. Luff and P. Rowley-Conwy (eds), *Whither Environmental Archaeology*, Oxbow Monograph 38. Oxford: Oxbow Books.

Perdikaris, S., R. McGovern, M.F. Brown, C. Look, D. McGovern, A. Palsdottir and K. Smiarowski, 2008. *Field report Barbuda historical ecology project 2008*. New York: Antigua and Barbuda National Parks Department and City University of New York.

Perez Merced, C.A., 2000. Excavaciones en Aguacate: una comunidad ceramista del este de Puerto Rico, in J. Winter (ed), *Proceedings of the Seventeenth International Congress for Caribbean Archaeolog*y. New York: Rockville Center, Molloy College, 157-65.

Perrot, J., 1960. Excavations at'eynan ('ein mallaḥa) preliminary report on the 1959 season. *Israel Exploration Journal* 10, 14-22.

Pestle, W.J., 2010. *Diet and society in prehistoric Puerto Rico. An isotopic approach.* Chicago (unpublished Ph.D. thesis University of Illinois).

Pestle, W., 2013. Fishing down a prehistoric Caribbean marine food web: isotopic evidence from Punta Candelero, Puerto Rico. *The Journal of Island and Coastal Archaeology* 8 (2): 228-54.

Petersen J.B. and D.R. Watters, 1995. A preliminary analysis of Amerindian ceramics from the Trants site, Montserrat, in R.E. Alegria and M. Rodriguez (eds), *Proceedings of the Fifteenth International Congress for Caribbean Archaeology*, Centro de Estudios Avanzados de Puerto Rico y el Caribe: San Juan, 131-40.

Pijoan, C.M.A., J. Mansilla and I. Leboreiro, 2007. Thermal alterations in archaeological bones. *Archaeometry* 49 (4), 713-27.

Pionnier-Capitan, M., C. Bemilli, P. Pierre, G. Célérier, J.G. Ferrié, P. Fosse, M. Garcià and J.D. Vigne, 2011. New evidence for Upper Palaeolithic small domestic dogs in South-Western Europe. *Journal of Archaeological Science* 38, 2123-40.

Plomp, E., 2013a. *Dogs on the move: a study concerning the mobility and exchange of dogs in prehistoric and contemporary circum-Caribbean Amerindian societies*. Leiden (unpublished R.M.A. thesis Leiden University, Leiden).

Plomp, E., 2013b. The evolving relationship between humans and dogs in the circum-Caribbean. *Archaeological Review from Cambridge* 28 (2), 96-112.

Plukowski, A., 2005. *Just skin and bones? New perspectives on human-animal relationships in the historical past.* Oxford: Archaeopress.

Plukowski, A., 2012. *The ritual killing and burial of animals: European perspectives*. Oxford: Oxbow Books.

Potts, R. and P. Shipman, 1981. Cut marks made by stone tools on bones from Olduvai Gorge, Tanzania. *Nature* 291, 577-80.

Pozorski, S.G., 1976. *Prehistoric subsistence patters and site economics in the Moche Valley, Peru*. Ann Arbor (unpublished Ph.D. thesis University of Texas, Austin).

Prates, L., F.J. Prevosti and M. Berón, 2010. First records of prehispanic dogs in southern South America (Pampa-Patagonia, Argentina). *Current Anthropology* 51 (2), 273-80.

Price, T.D., J.H. Burton and R.A. Bentley, 2002. The characterization of biologically available strontium isotope ratios for the study of prehistoric migration. *Archaeometry* 44, 117-35.

Ramos, A.R., 2012. The politics of perspectivism. *Annual Review of Anthropology* 41, 481-94.

Raven, J.A. and D. Edwards, 2001. Roots: evolutionary origins and biogeochemical significance. *Journal of Experimental Botany* 52 (90001), 381-401.

Reher, C.A., 1970. Population dynamics of the Glenrock Bison population, in G.C. Frison (ed), *The Glenrock Buffalo Jump 48CO384: Late Prehistoric Period Buffalo Procurement and Butchering on the Northwestern Plains*. Plains Anthropologist Memoirs, vol. 7, 51-55.

Reichel-Dolmatoff, G., 1976. Cosmology as ecological analysis: a view from the tropical rainforest. *Man* 2, 307-18.

Reichel-Dolmatoff, G. and A. Reichel-Domatoff, 1961. *The people of Aritama. The cultural personality of a Colombian mestizo village.* Chicago: University of Chicago Press.

Reidsma, F.H., 2014. *Fire, taphonomy & the Palaeolithic record: a laboratory-based experimental study into the influence of diagenesis on charred bone and wood.* Leiden (unpublished R.M.A. thesis Leiden University).

Rendu, W., 2010. Hunting behaviour and Neanderthal adaptability in the Late Pleistocene site of Pech-de-l'Aze. *International Journal of Archaeological Science* 37, 1798-810.

Repussard, A., H.P. Schwarcz, K.F. Emery and E.K. Thornton, 2014. Oxygen isotopes from Maya archaeological deer remains: experiments in tracing droughts using bones, in G. Iannone (ed), *The Great Maya Droughts in Cultural Context: Case Studies in Resilience and Vulnerability*. Boulder: University Press of Colorado, 231-54.

Richards, M.P., E. West, B. Rolett and K. Dobney, 2009. Isotope analysis of human and animal diets from the Hanamiai archaeological site (French Polynesia). *Archaeology in Oceania* 44, 29-37.

Rímoli, R.O., 1977. Nevas citas para mamiferos precolombinos en la Hispañiola. *Cuardenos del Cendia* 259 (5), 3-15.

Rival, L., 1998. *The social life of trees: anthropological perspectives on tree symbolism.* New York: Berg Publishers.

Rival, L., 2012. The materiality of life: revisiting the anthropology of nature in Amazonia. *Indiana* 29, 127-43.

Rival, L., 2014. Encountering nature through fieldwork: expert knowledge, modes of reasoning, and local creativity. *Journal of the Royal Anthropological Institute* 20, 218-36.

Rival, L., 2015. Huaorani peace: cultural continuity and negotiated alterity in the Ecuadorian Amazon. *Common Knowledge* 21 (2), 270-305.

Rival, L., 2016. Botanical ontologies special section of the journal of ethnobiology post-face. *Journal of Ethnobiology* 36 (1), 147-9.

Rivière, P., 1969. *Marriage among the Trio: A principle of social organization.* Oxford: Clarendon Press.

Rodriguez, M.L., 2007. *Tras las huellas del perro indígena*. Hato Rey: Publicaciones Puertorriquenas.

Rodríguez Ramos, R., 2013. Isthmo-Antillean engagements, in W.F. Keegan, C.L. Hofman and R. Rodríguez Ramos (eds), *The Oxford Handbook of Caribbean Archaeology*. Oxford: Oxford University Press, 155-70.

Roe, P.G., 1982. *The cosmic zygote: cosmology in the Amazon Basin.* New Brunswick: Rutgers University Press.

Roe, P.G., 1989. A grammatical analysis of Cedrosan Saladoid vessel form categories and surface decoration: aesthetic and technical styles in early Antillean ceramics, in Siegel, P.E. (ed), *Early Ceramic Population Lifeways and Adaptive Strategies in the Caribbean*. Oxford: British Archaeological Reports (BAR International Series, vol. 506), 267-382.

Roe P.G. 1995. Eternal companions: Amerindian dogs from *tierra firma* to the Antilles, in *Proceedings of the Fifteenth International Congress for Caribbean Archaeology, San Juan, Puerto Rico 1993*, 155-72.

Romon, T., 2006. Basse-Terre - Gare maritime. *ADLFI. Archéologie de la France - Informations*. DOI: http://adlfi.revues.org/4961.

Roosevelt, A., 1989. Resource management in Amazonia before the conquest: Beyond ethnographic projection. *Advances in Economic Botany* 7, 30-62.

Roosevelt, A.C., 1996. The origins of complex societies in Amazonia, in T. Hester, L. Laurencich-Minelli, S. Salvatori (eds), *The Prehistory of the Americas*. Forli: International Union of Prehistorica and Protohistoric Sciences/A.B.C.O. Edizioni, 27-31.

Roth, W.E., 1929. Weaving in South America. *American Anthropologist* 31 (3), 560.

Rouse, I., 1992. *The 'Taíno's: rise and decline of the people who greeted Columbus*. New Haven: Yale University Press.

Rouse, I. and B.F. Morse, 1999. *Excavations at the Indian Creek Site, Antigua West Indies*. New Haven: Yale University Publications in Anthropology.

Ruscillo, D., 2002. The table test: a simple technique for sexing canid humeri, in D. Ruscillo (ed), *Recent Advances in Ageing and Sexing Animal Bones*. *Proceedings of the 9th ICAZ Conference, Durham, 2002.* Oxford: Oxbow Books, 62-67.

Russell, N., 2011. *Social zooarchaeology: humans and animals in prehistory*. Cambridge University Press, Cambridge.

Sablin, M.V. and G.A. Khlopachev, 2002. The earliest Ice Age dogs: evidence from Eliseevichi. *Current Anthropology* 43, 795-9.

Samson, A.V.M., 2010. *Renewing the house. Trajectories of social life in the yucayeque (community) of El Cabo, Higüey, Dominican Republic, AD 800 to 1504*. Leiden: Sidestone Press.

Saunders, N.J., 2005. *The peoples of the Caribbean: an encyclopedia of archaeology and traditional culture*. Santa Barbara: ABC CLIO.

Scherer, A.K., A. Carteret and S. Newman, 2009. Local water resource variability and oxygen isotopic reconstructions of mobility: a case study from the Maya area. *Journal of Archaeological Science Reports* 2, 666-76.

Schlotthauer, C.F. and J.M. Janes, 1952. The time of closure of the lower femoral epiphysis and upper tibial epiphysis in the dog as determined by roentgenogram. *American Journal of Veterinary Research* 13, 90.

Schoeninger, M. J., M. J. DeNiro, and H. Tauber, 1983. Stable nitrogen isotope ratios of bone collagen reflect marine and terrestrial components of prehistoric human diet. *Science* 220, 1381-3.

Schwarcz, H. and M.J. Schoneninger, 1991. Stable isotope analysis in human nutritional ecology. *Yearbook of Physical Anthropology* 34 (13), 283-321.

Schwarcz, H.P., 2001. Some biochemical aspects of carbon isotopic palaeodiet studies, in S.H. Ambrose and M.H. Katzenberg (eds), *Biogeochemical Approaches to Paleodietary Analysis*. New York: Kluwer, 189-2009.

Schwartz, A. and R.W. Henderson, 1991. *Amphibians and reptiles of the West Indies*. Gainesville: University of Florida Press.

Schwartz, M., 1997. *A history of dogs in the early Americas*. New Haven: Yale University Press.

Sharp, Z., 2007. *Principles of stable isotope geochemistry*. Upper Saddle River: Pearson Prentice Hall.

Shepard, G.H., 2002. Primates in Matsigenka subsistence and world view, in A. Fuentes and L.D. Wolfe (eds), *Primates Face to Face: The Conservation Implications of Human-Nonhuman Primate Interconnections.* Cambridge: Cambridge University Press, 101-36.

Sherratt, A., 1981. Plough and pastoralism: Aspects of the secondary products revolution, in I. Hodder, G. Isaac and G. Hammond (eds), *Patterns of the Past: Studies in Honour of David Clarke.* Cambridge: Cambridge University Press, 261-305.

Shigehara, N., S. Onodera and M. Eto, 1997. Sex determination by discriminate analysis and an evaluation of non-metric traits in the dog skeleton, in S. J. Crockford (ed), *Osteometry of Makah and Coast Salish Dogs*. Barnaby: Archaeological Press, Simon Frazier University, 113-26.

Shipman, P., G. Foster and M. Schoeninger, 1984. Burnt bones and teeth: an experimental study of color, morphology, crystal structure and shrinkage. *Journal of Archaeological Science* 11, 307-25.

Siegel, P.E., 1989. Site structure, demography, and social complexity in the early ceramic age of the Caribbean, in P.E. Siegel (ed), *Early Ceramic Population Lifeways and Adaptive Strategies in the Caribbean*. Oxford: British Archaeological Reports (BAR International Series, vol. 506), 193-245.

Siegel, P.E., 1991. Migration research in Saladoid archaeology: a review. *Florida Anthropologist* 44 (1), 79-91.

Siegel, P.E., 2010. Continuity and change in the evolution and political organization on pre-colonial Puerto Rico. *Journal of Anthropological Archaeology* 29, 302-26.

Smith, B.N. and S. Epstein, 1971. Two categories of $^{13}C/^{12}C$ ratios for higher plants. *Plant Physiology* 47, 380-4.

Solari, A., D. Olivera, I. Gordillo, P. Bosch, G. Fetter, V.H. Lara and O. Novelo, 2013. Cooked bones? Method and practice for identifying bones treated at low temperature. *International Journal of Osteoarchaeology*. DOI: 10.1002/oa.2311.

Sonnemann, T.E., J. Ulloa Hung and C.L. Hofman, 2016. Mapping indigenous settlement topography in the Caribbean using drones. *Remote Sensing* 8, 791. DOI: 10.3390/rs8100791.

Sponheimer, M. and J.A. Lee-Thorp, 1999. Oxygen isotopes in enamel carbonate and their ecological significance. *Journal of Archaeological Science* 26, 723-8.

Sponsel, L.E., 1981. *The hunter and the hunted in the Amazon: an integrated biological and cultural approach to the behavioral ecology of predation*. Ithaca (unpublished Ph.D. thesis Cornell University).

Stahl, P., 2003. The zooarchaeological record from formative Ecuador, in J.S. Raymond and R.L. Burger (eds), *Archaeology of formative Ecuador*. Washington, DC: Dumbarton Oaks Research Library and Collection, 175-212.

Steadman, D.W., P.S. Martin, R.D.E. MacPhee, A.J.T. Jull, H. G. McDonald, C.A. Woods, M. Iturralde-Vinent and G.W.L. Hodgins, 2005. Asynchronous extinction of late Quaternary sloths on continents and islands. *PNAS* 102 (33), 11763-8.

Steele, K.W. and R.M. Daniel, 1978. Fractionation of nitrogen isotopes by animals: a further complication to the use of variations in the natural abundance of ^{15}N for tracer studies. *Journal of Agricultural Science* 90, 7-9.

Stevens, R.E., S. Metcalfe, M.J. Leng, E. Naranjo and S. Gonzalez, 2012. Reconstruction of Late Pleistocene climate in the Valsequillo Basin (Central Mexico) through isotopic analysis of terrestrial and freshwater snails. *Palaeogeography. Palaeoclimatology, Palaeoecology* 320, 16-27.

Steward, H., 2009. Animal agency. *Inquiry* 52, 217-31.

Stewart, T.D., 1979. *Essentials of forensic anthropology*. Sprinfield: Charles C. Thomas Company.

Stiner, M.C., 1990. The use of mortality patterns in archaeological studies of hominid predatory adaptations. *Journal of Anthropology and Archaeology* 9, 305-51.

Stiner, M.C., 1991. *Human predators and prey mortality*. Westview Press, Boulder.

Stokes, A. V. 1998. *A biogeographic survey of prehistoric human diet in the West Indies using stable isotopes.* Gainesville (unpublished Ph.D. thesis University of Florida).

Stone, H.R., P.D. McGreevy, M.J. Starling and B. Forkman, 2016. Associations between domestic-dog morphology and behaviour scores in the Dog Mentality Assessment. *PLOS One* 11 (2), e0149403. DOI: http://doi.org/10.1371/journal.pone.0149403.

Sugiyama, L.S. and R. Chacon, 2005. Juvenile responses to household ecology among the Yora of Peruvian Amazonia, in B.S. Hewlett and M.E. Lamb (eds), *Hunter-gatherer childhoods: Evolutionary, developmental, and cultural perspectives*. New Brunswick: Aldine/Transaction, 237-61.

Sugiyama, N., A.D. Somerville and M.J. Schoeninger, 2015. Stable isotopes and zooarchaeology at Teotihuacan, Mexico reveal earliest evidence of wild carnivore management in Mesoamerica. *PLOS One* 10 (9): e0135635.

Sumner-Smith, G., 1966. Observations on epiphyseal fusion of the canine appendicular skelton. *Journal of Small Animals* 7, 303-11.

Sweeney, R.E., K.K. Liu and I.R. Kaplan, 1978. Oceanic nitrogen isotopes and their uses in determining the source of sedimentary nitrogen, in R.W. Robinson (ed), *Stable Isotopes in the Earth Sciences.* Wellington: Department of Scientific and Industrial Research (New Zealand), 9-26.

Tauber, H., 1981. ^{13}C evidence for dietary habits of prehistoric man in Denmark. *Nature* 292, 332-3.

Taylor, A.C., 2001. Wives, pets, and affines: marriage among the Jivaro, in N.L. Whitehead and L.M. Rival (eds), *Beyond the Visible and Material: The Amerindianization of Society in the Work of Peter Rivière*. Oxford: Oxford University Press, 45-56.

Taylor, K.I., 1974. *Sanumá fauna: Prohibitions and classifications*. Caracas: Fundacion La Salle de Ciencias Naturales.

Tchernov, E. and F.F. Valla, 1997. Two new dogs, and other Natufian dogs, from the southern Levant. *Journal of Archaeological Science* 24, 65-95.

Thibodeau, A.M., D.J. Killick, J. Ruiz, J.T. Chesley, K. Deagan, J.M. Cruxent and W. Lyman, 2007. The strange case of the earliest silver extraction by European colonists in the New World. *PNAS* 104: 3663-6.

Ting, C., J. Ulloa Hung, C.L. Hofman and P. Degryse, 2018. Indigenous technologies and the production of early colonial ceramics in Dominican Republic. *Journal of Archaeological Science: Reports* 17, 47-57.

Turnbull, N., 1952. Injuries to the stifle joint in young dogs. *Veterinary Record* 64, 735.

Tuross, N., C. Warinner, K. Kirsanow and C. Kester, 2008. Organic oxygen and hydrogen isotopes in a porcine controlled dietary study. *Rapid Communications in Mass Spectrometry* 22, 1741-5.

Turvey, S.T., 2009. *Holocene extinctions*. Oxford: Oxford University Press.

Turvey, S.M., R. J. Kennerley, J. M. Nuñez-Miño and R.P. Young, 2017. The last survivors: current status and conservation of the non-volant land mammals of the insular Caribbean. *Journal of Mammalogy* 98 (4), 918-36.

Ugan, A., 2010. The effect of cooking on the survivorship of jackrabbit skeletons (*Lepus californicus*) presented to desert scavengers of the eastern Great Basin, North America. *International Journal of Osteoarchaeology* 20 (2), 214-26.

Ulloa Hung, J., 2014. *Arqueología. en la Línea Noroeste de La Española Paisajes, Cerámicas e Interacciones*. Santo Domingo: Instituto Tecnológico de Santo Domingo'.

Ulloa Hung, J. and E.N. Herrera Malatesta, 2015. Investigaciones arqueologicas en el norte de la Española. Entre viejos esquemas y nuevos datos. *Boletín el Museo del Hombre Dominicano* XLII (46), 75-107.

Valadez Azúa, R. 2000. Prehistoric dog types in Middle America, in S. Crockford (ed), *Dogs Through Time: An Archaeological Perspective*. British Archaeological Reports 889. Oxford: Archaeopress, 194-204

Valadez Azúa, R., A. Blanco Padilla, B. Rodríguez Galicia and G. Pérez Roldán, 2013. The dog in the Mexican archaeozoological record, in C.M. Götz and K.F. Emery (eds), *The Archaeology of Mesoamerican Animals*. Atlanta: Lockwood Press, 557-81.

Valadez Azúa, R., A. Blanco Padilla, B. Rodríguez Galicia, F. Viniegra Rodríguez and K. Olmos Jiménez, 2003. La investigación etnozoológica y el estudio del cánido mesoamericano. *AMMVEPE* 14 (6), 186-94.

Valcárcel Rojas, R., D.A. Weston, H.L. Mickleburgh, J.E. Laffoon, and A. van Duijvenbode, 2011. El Chorro de Maíta. A diverse approach to a context of diversity, in C.L. Hofman and A. van Duijvenbode (eds), *Communities in Contact: Essays in Archaeology, Ethnohistory & Ethnography of the Amerindian Circum-Caribbean*. Leiden: Sidestone Press, 225-52.

Valla, F.R., 1975. La sépulture H. 104 de Mallaha (Eynan) et le problème de la domestication du chien en Palestine. *Paleorient* 3, 287-92.

van Valkenburgh, B., 1990. Skeletal and dental predictors of body mass in carnivores, in J. Damuth, and B. Macfadden (eds), *Body Size in Mammalian Paleobiology: Estimation and Biological Implications*. New York: Cambridge University Press, 181-206.

Vásquez Sánchez, V. F., T.E. Rosales Tham, A. Morales Munĩz, and E. Rosello Izquierdo, 2003. Zooarqueología de la zona urbana Moche, complejo Huacas del Sol y de la Luna, valle de Moche, in S. Uceda and E. Mujica (eds), *Moche: Hacia el final del milenio, Actas del Segundo Coloquio sobre la Cultura Moche, Trujillo (1 al 7 de agosto de 1999).* Trujillo: Pontificia Universidad Católica del Perú, Universidad Nacional de la Libertad (Vol. 2), 33-63.

Velden, F.V., 2017. Narrating the first dogs: canine agency in the first contacts with indigenous peoples in the Brazilian Amazon. *Anthrozoös* 30 (4), 533-48.

Veloz Maggiolo, M., 1972. *Arqueología. Prehistórica de Santo Domingo*. Singapore: McGraw Hill.

Veloz Maggiolo, M., E. Ortega and A. Caba, 1981. *Los modos de vda Meillacoides y sus posibles orígenes.* Santo Domingo: Editora Taller.

Veltham, L.H. van., 2003. *O belo é a fera: a estética da produção e da predação entre os Wayana*. Lisboa: Assírio & Alvim.

Vigne, J.D., 2005. L'humérus de chien magdalénin de Erralla (Gipuzkoa, Espagne) te la domestication tardiglaciaire du loup en Europe. *Munibe* 57, 279-87.

Vilaça, A., 1992. *Commendo como gente: formas do canibalismo wari'(pakaa-nova)*. Rio de Janeiro: Editora da UFRJ.

Villamañan, A. de, 1982. El mundo social y religioso de los Yukpa. *Antropológica* 57, 3-24.

Viveiros de Castro, E., 1978. Alguns aspectos do pensamento yawalapíti (Alto Xingu): classificações e transformações. *Boletim do Museu Nacional* 26, 1-41.

Viveiros de Castro, E., 1998. Cosmological deixis and Amerindian perspectivism. *The Journal of the Royal Anthropological Institute* 4 (3), 469-88.

Viveiros de Castro, E., 2004. Exchanging perspectives: the transformation of objects into subjects in Amerindian ontologies. *Common Knowledge* 10 (3), 463-84.

Viveiros de Castro, E., 2011. Zeno and the art of anthropology. *Common Knowledge* 17(1), 128-45.

Viveiros de Castro, E., 2015. *The relative native: Essays on indigenous conceptual worlds.* Chicago: HAU Press.

Vogel, J.C., 1993. Variability of carbon isotope fractionation during photosynthesis, in J.R. Ehleringer, A.E. Hall and G.D. Farquhar (eds), *Stable isotopes and plant carbon-water relations*. Cambridge: Academic Press, 29-46.

Vogel, J.C. and N.J. van der Merwe, 1977. Isotopic evidence for early maize cultivation in New York State. *American Antiquity* 42, 238-42.

von den Driesch, A., 1976. *A guide to the measurement of animal bones from archaeological sites*. Cambridge: Peabody Museum of Archaeology and Ethnology, Harvard University.

Wada, E. and A. Hattori, 1976. Natural abundance of ^{15}N in particulate organic matter in the North Pacific Ocean. *Geochimica et Cosmochimica Acta* 40, 249-51.

Wada, E., T. Kadonaga and S. Matsuo, 1975. ^{15}N abundance in nitrogen of naturally occurring substances and global assessment of denitrification from isotopic viewpoint. *Geochemical Journal* 9, 139-48.

Waldron, L., 2010. *Like turtles, islands float away: emergent distinctions in the zoomorphic iconography of Saladoid ceramics of the Lesser Antilles, 250 BCE to 650 CE.* New York (unpublished Ph.D. thesis The City University of New York).

Walker, J.B., 1985. A preliminary report on the lithic and osteological remains from the 1980, 1981 and 1982 field season at Hacienda Grande (12 PSJ7-5), in *Proceedings of the tenth International Congress for the Study of the Pre-Columbian Cultures of the Lesser Antilles*. Montreal: Centre de Recherches Caraibes, 181-224.

Wauben, N., 2018. *Expressive and performative material culture: investigating the social roles of ceramic adornos from the site of El Flaco (13th – 15th century) in the northwestern Dominican Republic*. Leiden (unpublished R.M.A. thesis Leiden University).

West, C.F., and C.A. France, 2015. Human and canid dietary relationships: comparative stable isotope analysis from the Kodiak archipelago, Alaska. *Journal of Ethnobiology* 35 (3), 519-35.

White, T.D., 1992. *Prehistoric cannibalism at Macos 5MTUMR-2346.* Princeton: Princeton University Press.

Wilbert, J., 1970. *Folk literature of the Warao Indians: Narrative material and motif content*. Los Angeles: UCLA Latin American Centre.

Wilbert, J., 1972, *Survivors of Eldorado: four Indian cultures of South America*. New York: Praeger.

Wilbert, J., 1974. *Yukpa folktales*. UCLA Latin American Studies Series Vol. 24. Los Angeles: Latin American Centre, University of California.

Wilson, S.M., 2007. *The archaeology of the Caribbean*. New York: Cambridge University Press.

Wing, E.S., 1972. Identification and interpretation of faunal remains from the white marl site in Jamaica, in J. Silverberg, R.L. Vanderwal and E.S. Wing (eds), *The White Marl Site in Jamaica: Report of the 1964 Robert R. Howard Excavation*. Milwaukee: University of Wisconsin-Milwaukee, 18-35.

Wing, E.S. 1989. Human use of canids in the central Andes, in K.H. Redford and J.F. Eisenberg (eds), *Advances in Neotropical Mammalogy*. Gainesville: Sandhill Crane, 265-78.

Wing, E.S., 1991. Dog remains from the Sorcé site on Vieques Island, Puerto Rico, in J.R. Purdue, W.E. Klippel, B.H. Styles, P.W. Parmalee (eds), *Beamers, Bobwhites and Blue-points: Tributes to the career of Paul W. Parmalee*. Springfield: Illinois State Museum, 379-86.

Wing, E.S., 2001. Native American use of animals in the Caribbean, in C.A. Woods and F.E. Sergile (eds), *Biography of the West Indies, Patterns and Perspectives*. Boca Raton: CRC Press, 481-518.

Wing, E.S., 2008. Native pets and camp followers in the West Indies, in E. Reitz, C.M. Scarry, S.J. Scudder (eds), *Case Studies in Environmental Archaeology*, 2nd ed. New York: Springer, 404-25.

Worthington, B.E., 2008. *An osteometric analysis of Southeastern prehistoric domestic dogs*. Tallahassee (unpublished Ph.D. thesis Florida State University).

Wroe, S., T.J. Myers, R.T. Wells and A. Gillespie, 1999. Estimating the weight of the Pleistocene marsupial lion, Thylacoleo carnifex (Thylacoleonidae: Marsupialia): implications for the ecomorphology of a marsupial super-predator and hypotheses of impoverishment of Australian marsupial carnivore faunas. *Australian Journal of Zoology* 47, 489-98.

Wyrost, P. and J. Kucharczyk, 1967. Analysis einiger Parameter des Hundesschädels hinischtlich ihres morphologischen Wertes. *Acta Theriol* 12, 293-322.

Yde, J., 1965. *The material culture of the Waiwái*. Copenhagen: National Museum of Copenhagen.

Zeder, M.A., 2012. Pathways to animal domestication, in P. Gepts, T.R. Famula and R.L. Bettinger *et al.* (eds), *Biodiversity in Agriculture: Domestication, Evolution, and Sustainability*. Cambridge: Cambridge University Press, 227-59.

Zent, E.M.L., 1999. *Hoti ethnobotany: Exploring the interactions between plants and people in the Venezuelan Amazon.* Athens (unpublished Ph.D. thesis University of Georgia).

Zeuner, F.E., 1963. *A history of domesticated animals*. New York: Harper & Row.

Figures, Tables, Appendices

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Appendix A: All identified taxa from excavations conducted at El Flaco and El Carril, including NISP and weights

El Flaco 2016 Faunal assemblage	**NISP**	**BURNT**	**% NISP**	**WEIGHT (g)**	**% WEIGHT**	**AVE. WEIGHT PER SPECIMEN (g)**
Small mammal	**5806**	**252**	**20.28%**	**3374**	**17.33%**	**0.58**
Rodentia	5793	0	20.24%	3368	17.30%	0.58
Nesophontes sp. (West Indies shrew)	9	0	0.03%	4	0.02%	0.44
Chiropterae (bat)	4	0	0.01%	2	0.01%	0.50
Medium mammal	**100**	**6**	**0.35%**	**120**	**0.62%**	**1.20**
Canis lupus familiaris (dog)	33	0	0.12%	51	0.26%	1.55
Avian	**1478**	**43**	**5.16%**	**394**	**2.02%**	**0.27**
Reptile	**2153**	**102**	**7.52%**	**1175**	**6.03%**	**0.55**
Lizard	1760	51	6.15%	537	2.76%	0.31
Cyclura sp.	7	0	0.02%	4	0.02%	0.57
Anurae (frogs)	16	0	0.06%	8	0.04%	0.50
Snake	11	0	0.04%	5	0.03%	0.45
Trachemys sp. (freshwater turtle)	366	51	1.28%	625	3.21%	1.71
Land crab	**18249**	**2685**	**63.75%**	**13997**	**71.88%**	**0.77**
						\
Fish	**840**	**23**	**2.93%**	**412**	**2.12%**	**0.49**
Scaridae (parrotfish)	4	2	0.01%	9	0.05%	2.25
Selachimorphae (shark)	1	0	0.00%	7	0.04%	7.00
TOTAL	**28626**	**3111**		**19472**		

Table 17: Identified fauna from the 2016 field season at El Flaco including a tally of NISP, weight calculations, and the average weight of each individual specimen. Marine invertebrates are excluded.

El Carril 2017 Faunal assemblage	**NISP**	**BURNT**	**% NISP**	**WEIGHT (g)**	**% WEIGHT**	**AVE. WEIGHT PER SPECIMEN (g)**
Small mammal	**6175**	**69**	**38.37%**	**2796**	**23.47%**	**0.45**
Rodentia	6153	69	38.24%	2776	23.31%	0.45
Nesophontes sp.	21	0	0.13%	15	0.13%	0.71
Chiropterae (bat)	1	0	0.01%	1	0.01%	1.00
Medium mammal	**92**	**1**	**0.57%**	**86**	**0.72%**	**0.93**
Canis lupus familiaris (dog)	29	0	0.18%	46	0.39%	1.59
Avian	**2049**	**26**	**12.73%**	**678**	**5.69%**	**0.33**
Falco peregrinus (peregrine falcon)	1	0	0.01%	1	0.01%	1.00
Reptile	**2425**	**27**	**15.07%**	**1373**	**11.53%**	**0.57**
Lizard	1995	13	12.40%	621	5.21%	0.31
Cyclura sp. (iguana)	10	0	0.06%	11	0.09%	1.10
Anurae (frogs)	2	0	0.01%	1	0.01%	0.50
Snake	27	0	0.17%	14	0.12%	0.52
Trachemys sp. (freshwater turtle)	401	14	2.49%	737	6.19%	1.84
Land crab	**3813**	**108**		**2130**	**17.88%**	**0.56**
Fish	**1538**	**15**	**9.56%**	**610**	**5.12%**	**0.40**
Scaridae (parrotfish)	12	0	0.07%	10	0.08%	0.83
Sciaenidae (drum)	2	0	0.01%	1	0.01%	0.50
Selachimorphae (shark)	2	0	0.01%	2	0.02%	1.00
Scombridae (bonita, mackeral, tuna)	1	0	0.01%	1	0.01%	1.00
Serranidae (bass, grouper)	1	0	0.01%	1	0.01%	1.00
TOTAL	**16092**	**342**		**11911**		

Table 18: Identified fauna from the 2017 field season at El Carril including a tally of NISP, weight calculations, and the average weight of each individual specimen. Marine invertebrates have been excluded.

El Flaco Total Faunal assemblage	**WEIGHT (g)**	**% of WEIGHT**
Mammal	5674	21.68%
Estimated weight of *C.familiaris*	55.5	0.21%
Avian	428.2	1.64%
Trachemys sp. (freshwater turtle)	586.8	2.24%
Reptile	1504	5.75%
Land Crab	17325.76	66.19%
Fish	603.2	2.30%
TOTAL	26177.46	

Table 19: Total weights of fauna categories from El Flaco, Dominican Republic

Appendix B: Qualitative database of *C. familiaris* specimens from El Flaco and El Carril

Table 20: Qualtitative data listing specificities of all C. familiaris skeletal elements, including fusion (F- fused; PF- partially fused; UF- unfused), percentage of completion, general notes, and age estimations based on epiphyseal fusion and dental eruption rates

PROJECT	FND	ID NO.	SIDE	BUTCHERY	FUSED	ELEMENT	% of COMPLETION	NOTES	Age estimate
CA16	30	4	L	N	-	Upper P2	-	Fully formed fragment. Distal cusp and root only	>5mths
FL15	2270	5	-	N	F	Pelvis	-	Both sides- disarticulated. Right innominate is missing pubis section. Measurements from Driesch 82-83	>9mths
CA17	419	6.1	R	N	F	Scapula	20	Largely fragmented, missing spine, only has coracoid	N/A
CA17	424	6.16	R	N	PF	Calcaneus	40	Partially fused	5-7mths
CA17	419	6.2	L	N	F	Scapula	20	Largely fragmented, missing spine, only has coracoid	N/A
CA17	396	6.23	L	N	MF	Calcaneus	80	Partially unfossiled, there is the possibility this may belong to a different individual although this is not certain	5-7mths
CA17	424	6.24	L	N	-	2nd metatarsal	80	Missing distal epiphysis- fractured	N/A
CA17	424	6.25	L	N	-	3rd metatarsal	80	Missing distal epiphysis- fractured	N/A
CA17	424	6.26	R	N	F	5th metatarsal	100		>5-8mths
CA17	424	6.26	L	N	-	4th metatarsal	50	Missing distal epiphysis- fractured	N/A
CA17	424	6.27	L	N	-	5th metatarsal	80	Missing distal epiphysis- fractured	N/A
CA17	419	6.3	R	N	-	Radius	10	Distal shaft fragment, close to distal diaphysis	N/A
CA17	419	6.6	L	N	F	Ulna	30	Proximal epiphysis- trochlear notch, fully fused. Measurements from Driesch 79-81	>5-8mths
FL16	3170	8	-	N	-	Lumbar vertebra- number unknown	-	Lumbar vertebra, spinal process and transverse processes broken off.	N/A
FL16	2801	10	R	N	F	4th metacarpal	40	Distal shaft and epiphysis	>5-7mths
FL16	2821	11	L	N	F	5th metacarpal	100	Intact	>5-7mths
FL16	2821	11.1	L	N	F	2nd metacarpal	80	Missing distal epiphysis- fractured	>5-7mths
FL16	2821	11.2	L	N	F	5th proximal phalange	100	Intact	>4-5mths
FL16	2812	12	-	N	-	Rib	-	Rib articulation and rib fragment	N/A
FL16	3444	13	R	N	-	c1	-	Deciduous lower c1, root fragmented at base.	<5mths

PROJECT	FND	ID NO.	SIDE	BUTCHERY	FUSED	ELEMENT	% of COMPLETION	NOTES	Age estimate
FL16	3269	14	L	N	-	Lower deciduous teeth- dp4 and 2x i2s. Two small mandible fragments.	-	Puppy mandible and teeth	<4mths
CA17	729	15	R	N	F	Mandible with ramus	-	Missing frontal portion and condyle on ramus- both fresh breaks. Contains P2-P4 and M2. Measurements from Driesch p. 60-61.	>4-6mths
CA17	729	15.1	R	N	-	Lower M2	-	Driesch p. 60-61	>5mths
FL16	3491	16	L	N	-	Mandible	-	Puppy mandible- completely destroyed during transportation. Had one P3 and an erupting P4	<5mths
FL16	2825	17	-	N	-	Rib	-	Four split fragments, one of them the articulation section	N/A
FL16	2825	17.1	-	N	-	Radius	10	Radius fragment- side uncertain	N/A
FL16	3261	19	L	N	-	Mandible	-	Distal fragment- contains P3, no P4 and an erupting M1	<4mths
FL16	3261	19.1	L	N	-	Maxilla	-	dp4 - loose. Section of mandible fragment	<4mths
FL16	2838	20	-	N	F	Phalanx 2	100	Fully formed	>4-7mths
FL16	2838	20.1	-	N	F	Phalanx 3	100	Fully formed ungual phalanx	>4-7mths
FL16	2798	21	L	N	UF	Ulna	-	Missing proximal portion- olecranon behind the trochlear notch- unfused. Distal shaft missing.	<5-8mths
FL16	2950	22	R	N	-	c1	-	Deciduous upper c1, root fragmented at base	<5mths
FL16	2828	23	L	N	-	Maxilla fragment	-	containing sockets for P2-M1. Appears much smaller than the skull #29. Likely juvenile as tooth sockets are different in shape- deciduousMeasurements Driesch 42-45.	>5mths
FL16	2828	23.1	L	N	-	Upper I2	-		>5mths
CA17	716	24	L	N	-	Humerus	30	Distal shaft fragment. Missing distal epiphysis- Fractioning pattern - proximal	<5-8mths
CA17	687	25	R	N	-	Lower M1	-	Fully formed, little to no wear. Measurements Driesch 60-61.	>4-5mths
FL16	3056	26	-	N	-	1st lumbar vertebra	-	Transverse processes broken off, however they are short indicating it is the most cranial of lumbar vertebrae	N/A
FL16	3050	27	-	N	-	Thoracic vertebra	-	Largely complete with left transverse process either unfused or broken off, very worn.	N/A
FL16	3050	27.1	-	N	-	Thoracic vertebra	-	Spinal process only	N/A
FL16	2610	28	R	N	-	Ulna	-	Highly weathered, fractured into three segments. Missing proximal epiphysis- olecranon- unsure if unfused or worn	N/A

PROJECT	FND	ID NO.	SIDE	BUTCHERY	FUSED	ELEMENT	% of COMPLETION	NOTES	Age estimate
FL15	2270	29	-	N	F	Skull- maxilla	-	Missing all teeth except for canines. Right zygomat brokemn off. Left split in the middle. Measurements - Driesch 42-45	>5mths
FL14	731	30	L	N	UF	Humerus	20	Distal shaft fragment- distal epiphysis unfused. Taphonomically moderately eroded.	<5-8mths
CA17	771	31	L	N	-	Maxilla	10	Left maxilla fragment with sockets of P3 and P4	>5mths
FL16	2649	32	L	N	PF	Femur	80	Partially fused proximal epiphysis, head is unfused but articulates. Partially fused greater and lesser tronchanters. Missing distal diaphysis- unfused	6-9mths
CA17	722	33	L	N	UF	Ulna	30	Mid shaft, including trochlear notch. Broken mid shaft. Unfused proximally.	<10mths
CA17	717	34	L	N	-	Femur	10	Proximal shaft fragment with possible intentional fracturing- possible butchery scar as well.	N/A
CA17	701	35	R	N	-	Upper C1	-	Fully formed	>5mths
CA17	903	36	R	N	-	Lower C1	-	Distal half missing, roots and crown of tooth missing	>5mths
FL16	2838	40	R	N	-	Upper P2	-	Distal cusp and root- lingual missing	>4-5mths
CA17	716	41	R	N	-	Lower C1	-	Fully formed- likely same individual as 43 due to situ and size of canines	>5mths
FL16	2812	42	R	N	-	Upper P1	-	Fully formed	>4mths
CA17	722	43	L	N	-	Lower C1	-	Fully formed	>5mths
FL16	2812	44	L	N	UF	Radius	10	Distal epiphysis	<6-9mths
FL16	2838	45	L	N	F	Radius	70	Proximal shaft, proximal epiphysis fused. Missing distal shaft and epiphysis. Evidence ofpossible gnawing on caudal side mid shaft.	>5-8mths
FL16	2838	46	-	N	-	Thoracic vertebra	-	Fully intact thoracic vertebra	N/A
FL16	2838	46.1	-	N	-	Rib	-	Fragment, no diagnostics	N/A
CA17	419	6,11, 6,12, 6,13	R	N	-	Femur	50	Proximal shaft fragment, femoral head and distal epiphysis all diarticulated	N/A
CA17	419	6,14, 6,15	R	Y - 2 parallel marks	PF	Tibia	100	Mostly fused proximal end and completely fused distal epiphysis	>6-11mths
CA17	424	6,17, 6,18, 6,19	L	N	UF	Femur	50	Proximal diaphysis unfused, femer mid diaphysis with fresh break, femur condyles/distal epi, unfused	6-8mths
CA17	424	6,20, 6,21, 6,22	L	Y- 2 faint parallel marks nearproximal break	F	Tibia	100	In three sections- faint butchery marks. Fracture pattern likely due to trampling though.	>6-11mths

PROJECT	FND	ID NO.	SIDE	BUTCHERY	FUSED	ELEMENT	% of COMPLETION	NOTES	Age estimate
CA17	419	6,4 6,5	L	N	PF	Humerus	40	Almost completely fused distal shaft and epiphysis, unfused humeral head/prox epiphys	5-8mths
CA17	419	6,7, 6,8, 6,9	L	N	F	Radius	80	In three fragments, missing midshaft fragments, fully fused	>6-9mths

Table 21: Osteometrics of each individual *C. familiaris* post-cranial skeletal element from El Flaco and El Carril. Abbreviations represent different standardised measurement criteria as outlined in von den Driesch (1976). Measurements are in millimetres (mm)

PROJECT	FND	ID NO.	SIDE	ELEMENT	GL	Bd	Bp	SD	HC	FC	SDO	DPA	L	B	H	LA	LAR	LS	SH	SB	LFo
CA16	30	4	L	Upper P2																	
FL15	2270	5	-	Pelvis	122.4											24.5	18.5	31.6	14.1	7.7	23.6
CA17	419	6.1	R	Scapula																	
CA17	424	6.16	R	Calcaneus																	
CA17	419	6.2	L	Scapula																	
CA17	396	6.23	L	Calcaneus																	
CA17	424	6.24	L	2nd metatarsal																	
CA17	424	6.25	L	3rd metatarsal																	
CA17	424	6.26	R	5th metatarsal	56.46	6.6															
CA17	424	6.26	L	4th metatarsal																	
CA17	424	6.27	L	5th metatarsal																	
CA17	419	6.3	R	Radius																	
CA17	419	6.6	L	Ulna							18.3	20.5									
FL16	3170	8	-	Lumbar vertebra-number unknown																	
FL16	2801	10	R	4th metacarpal		7.16															
FL16	2821	11	L	5th metacarpal	44.15																
FL16	2821	11.1	L	2nd metacarpal																	
FL16	2821	11.2	L	5th proximal phalange																	
FL16	2812	12	-	Rib																	
FL16	3444	13	R	c1																	

PROJECT	FND	ID NO.	SIDE	ELEMENT	GL	Bd	Bp	SD	HC	FC	SDO	DPA	L	B	H	LA	LAR	LS	SH	SB	LFo
FL16	3269	14	L	Lower deciduous teeth- dp4 and 2x i2s. Two small mandible fragments.																	
CA17	729	15.1	R	Lower M2																	
FL16	3491	16	L	Mandible																	
FL16	2825	17	-	Rib																	
FL16	2825	17.1	-	Radius																	
FL16	3261	19	L	Mandible																	
FL16	3261	19.1	L	Maxilla																	
FL16	2838	20	-	Phalanx 2	13.39	5.54	6.08	3.96													
FL16	2838	20.1	-	Phalanx 3	13.43																
FL16	2798	21	L	Ulna																	
FL16	2950	22	R	c1																	
FL16	2828	23	L	Maxilla fragment																	
FL16	2828	23.1	L	Upper I2																	
CA17	716	24	L	Humerus											33.4						
CA17	687	25	R	Lower M1									20.7	7.8							
FL16	3056	26	-	1st lumbar vertebra																	
FL16	3050	27	-	Thoracic vertebra																	
FL16	3050	27.1	-	Thoracic vertebra																	
FL16	2610	28	R	Ulna																	
FL14	731	30	L	Humerus																	
CA17	771	31	L	Maxilla																	
FL16	2649	32	L	Femur			23.8	9.02		28.3											
CA17	722	33	L	Ulna																	
CA17	717	34	L	Femur																	

PROJECT	FND	ID NO.	SIDE	ELEMENT	GL	Bd	Bp	SD	HC	FC	SDO	DPA	L	B	H	LA	LAR	LS	SH	SB	LFo
CA17	701	35	R	Upper C1																	
CA17	903	36	R	Lower C1																	
FL16	2838	40	R	Upper P2																	
CA17	716	41	R	Lower C1											33.6						
FL16	2812	42	R	Upper P1																	
CA17	722	43	L	Lower C1											33.4						
FL16	2812	44	L	Radius			19.8														
FL16	2838	45	L	Radius																	
FL16	2838	46	-	Thoracic vertebra																	
FL16	2838	46.1	-	Rib																	
CA17	419	6,11, 6,12, 6,13	R	Femur																	
CA17	419	6,14, 6,15	R	Tibia	156.7	18.8	28	10.1													
CA17	424	6,17, 6,18, 6,19	L	Femur																	
CA17	424	6,20, 6,21, 6,22	L	Tibia	156.4	18.1	27.3	10.8													
CA17	419	6,4 6,5	L	Humerus		28.3															
CA17	419	6,7, 6,8, 6,9	L	Radius		19.1	15														

Table 22: Osteometrics of individual C. familiaris cranial element from El Flaco and El Carril. Numerals in the header row (in *blue)* represent different standardised measurement criteria as outlined in von den Driesch (1976). An extra row (numerals 20-39) is included for FND 2270 due to the extra measurement criteria for skulls. Measurements are in millimetres (mm)

PROJECT	FND	ID NO.	SIDE	ELEMENT	1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	18
CA17	729	15	R	Mandible with ramus									64.1	32	32					10	45.9

PROJECT	FND	ID NO.	SIDE	ELEMENT	1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17
FL15	2270	29	-	Skull-maxilla	152.1	148	135	42	98.7		83.3	73.5	89.1	55	61.3	76.8	41.3	55.2	18.1	45
					20	**23**	**24**	**25**	**26**	**27**	**29**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**
					19.03	59.4	33.2	48.1	22.23	12	49	35.8	46.6	34	55.8	30.9	32	27.1	51.2	51

Appendix C: Photographs of *C. familiaris* specimens from El Flaco and El Carril

Figure 40: (a) FL16, no FND no. - left ulna, lateral view; (b) medial view; (c) CA17, FND 424- left 5th metatarsal, palmar view; (d) dorsal view; (e) CA17 FND 33 – left ulna, lateral view; (e) medial view (copyright NEXUS1492, photographed by author)

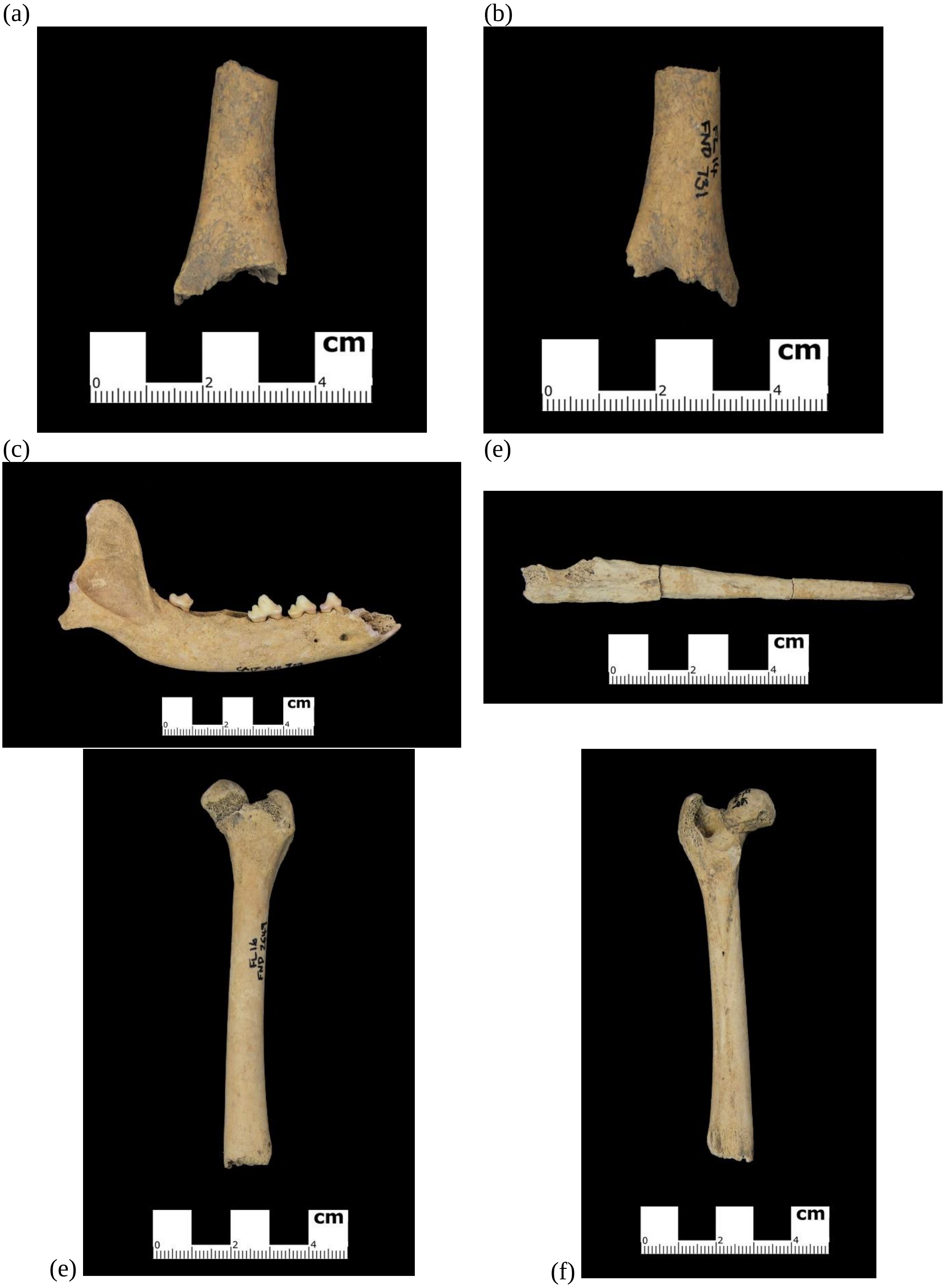

Figure 41: (a) FL14 FND 731- right humerus, anterior view; (b) posterior view; (c) CA17 FND 729 – right mandible; (d) FL16 FND 2610- right ulna, medial view; (e) FL16 FND 2649- left femur, anterior view; (f) posterior view (copyright NEXUS1492, photographed by author)

Figure 42: (a) FL16 FND 2801- right 4th metacarpal, dorsal view; (b) palmar view; (c) FL16 FND 2828- left maxilla fragment; (d) FL15 FND 2838- left radius; (e) FL16 FND 3170- lumbar vertebra, anterior view; (f) lateral view (copyright NEXUS1492, photographed by author)

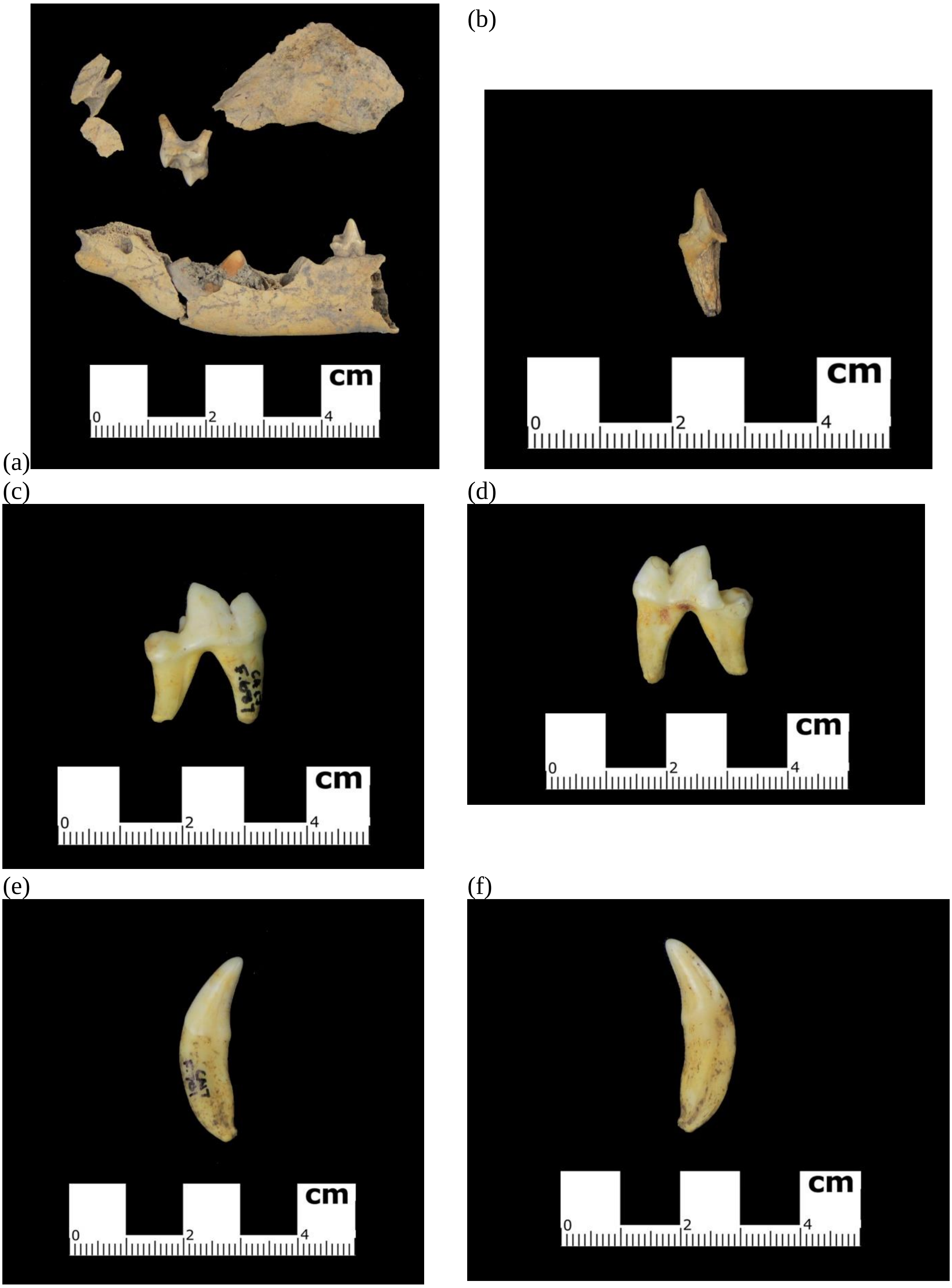

Figure 43: (a) FL16 FND 3261- left mandible fragment with loose tooth; (b) CA16 FND 30- left upper P2; (c) CA17 FND 687- lower M1, buchal view; (d) lingual view; (e) CA17 FND 701- upper C1, buchal view; (f) lingual view (copyright NEXUS1492, photographed by author)

Figure 44: (a) CA17 FND 716- lower right C1, buchal view; (b) lingual view; (c) CA17 FND 722- lower left C1, buchal view; (d) lingual view; (e) CA17 FND 903- lower right C1 fragment; (f) FL16 FND 2812- upper right P1, lingual view (copyright NEXUS1492, photographed by author)

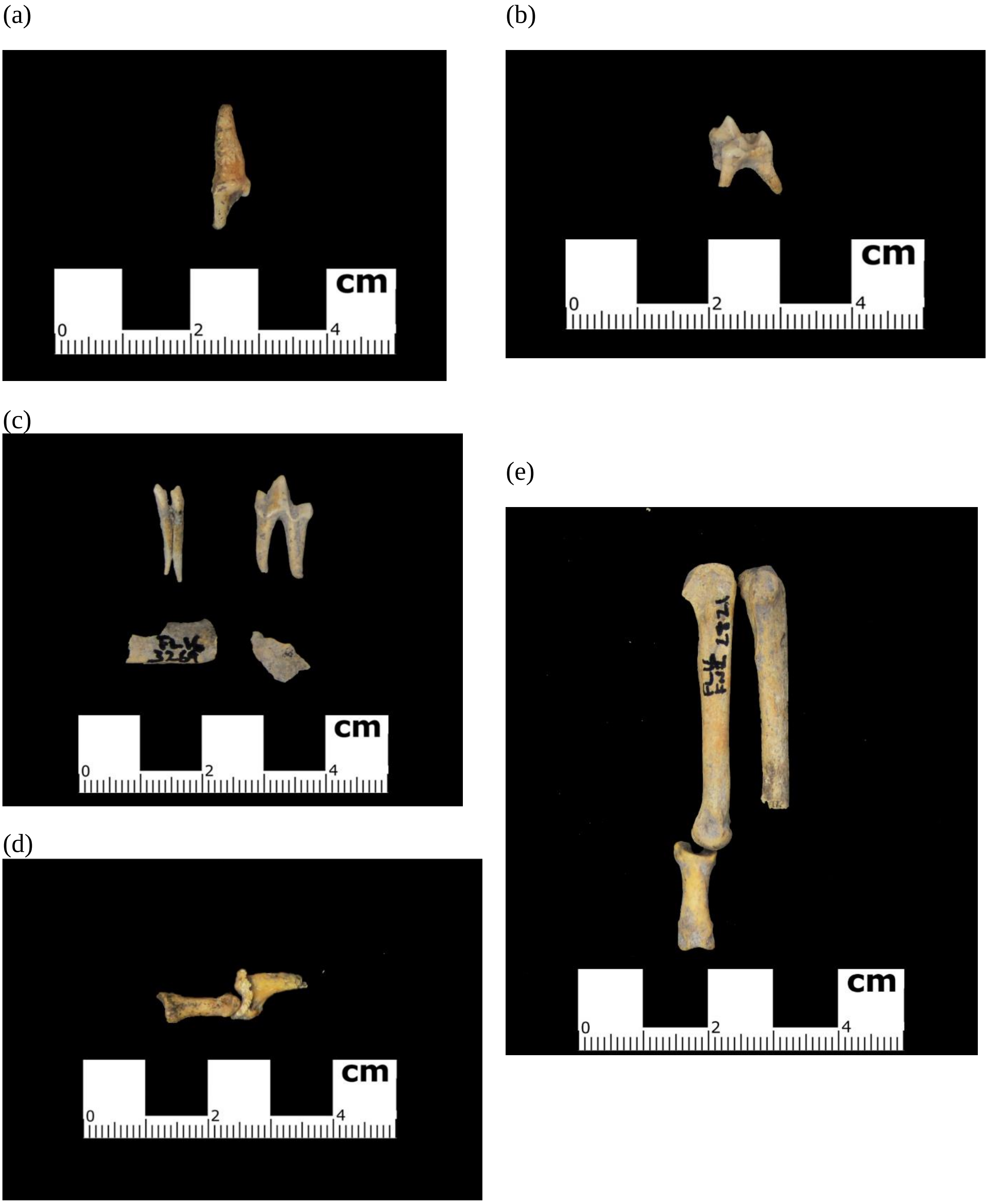

Figure 45: (a) FL16 FND 2838- upper right P2 fragment; (b) FL16 FND 3261- upper left dp4; (c) FL16 FND 3269- mandibular fragments and loose teeth- dp4 and two i2's; (d) FL16 FND 2838- middle and ungual phalanges; (e) FL16 FND 2821- left 5th metacarpal with articulating proximal phalanx and left 2nd metacarpal (copyright NEXUS1492, photographed by author)

Figure 46: CA17 FND 396, 419, 424- Disarticulated skeleton uncovered from Unit 10 at El Carril, primarily consisting of appendicular elements with no axial and cranial elements (copyright NEXUS1492, photographed by author)

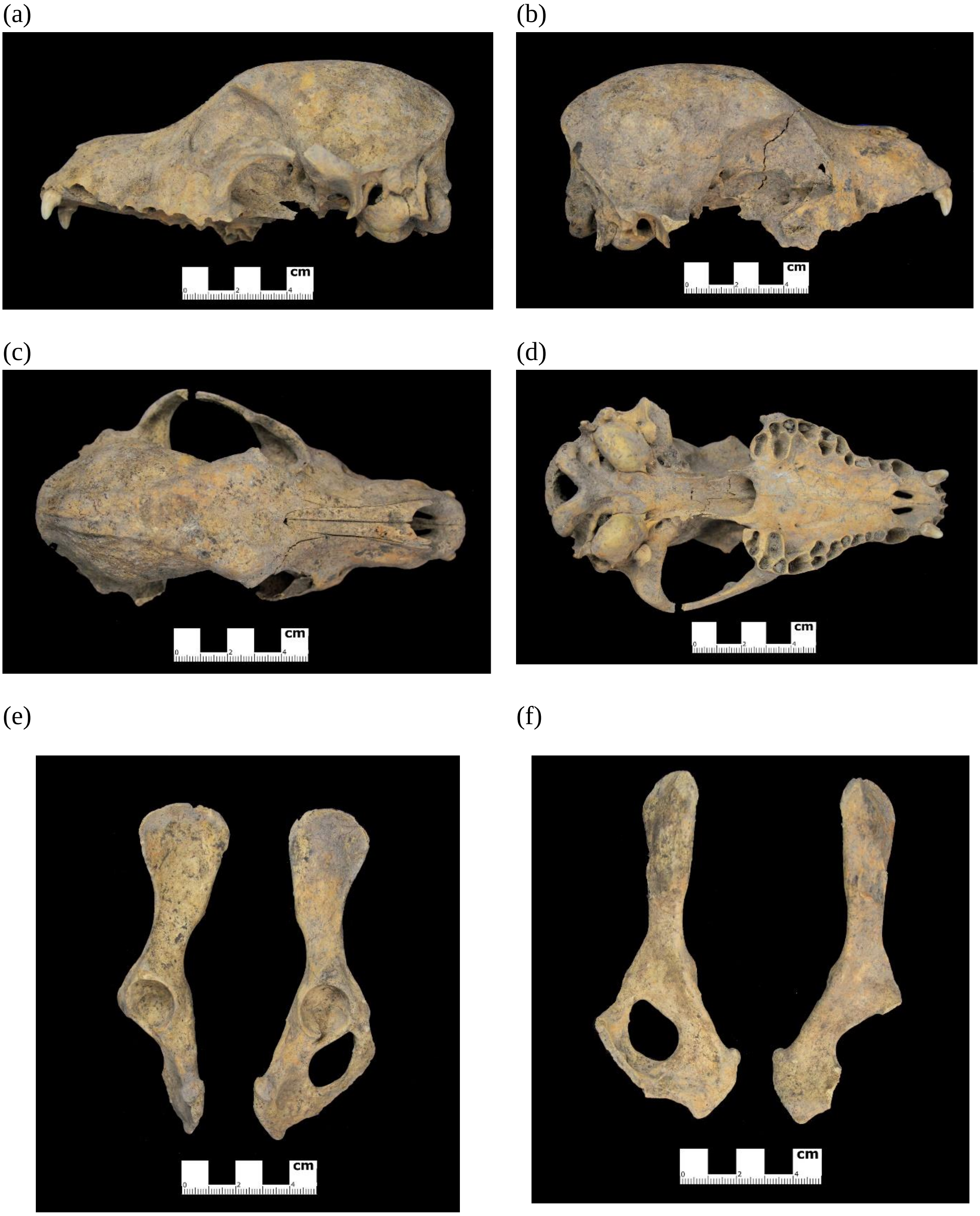

Figure 47: FL16 FND 2270- Interred skull and pelvis recovered in association with human burials (a) upper skull, left view; (b) right view; (c) top view; (bottom view); (e) innominates, anterior view; (f) posterior view (copyright NEXUS1492, photographed by author)