Integrating Stable Isotope and Zooarchaeological Analyses in Historical Archaeology: A Case Study from the Urban Nineteenth-Century Commonwealth Block Site, Melbourne, Australia

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Abstract This paper presents the first use of bone collagen stable isotope analyses for the purpose of reconstructing historical animal husbandry and trade practices in Australia. Stable carbon and nitrogen isotope analyses of 51 domesticate and commensal specimens demonstrate that meats consumed at the mid to late nineteenth-century Commonwealth Block site in Melbourne derived from animals with a diverse range of isotopic signatures. Potential factors contributing to this diversity including animal trade and variability in local animal husbandry practices are discussed. From these results we suggest that stable isotope-based paleodietary reconstructions have significant potential to illuminate a variety of human-animal relations in Australia’s historical period as well as other New World contexts.

Keywords Stable isotopes · Animal husbandry · Trade · Australia

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Introduction

Stable isotope analyses have become a well-established technique in archaeological science for reconstructing past dietary regimes and patterns in mobility (for reviews see Katzenberg 2008; Pate 1994; Sealy 2001). The aim of this paper is to emphasize and explore the potential of applying stable isotope analyses to questions of human-animal relations in historical contexts in Australia through the use of a case study - the analysis of faunal material from the Commonwealth Block site in Melbourne (Fig. 1).

An outline of theoretical underpinnings for stable carbon and nitrogen isotope analysis of archaeological bone collagen is followed by a brief overview of previous stable isotope research with particular attention to studies focusing on Australian archaeology, historical contexts, and human-animal relations. In this context, a case study using the first stable carbon and nitrogen isotope analyses aimed at reconstructing animal husbandry and trade in an Australian context is presented.

The case study consists of stable carbon and nitrogen isotope values obtained from the bone collagen of 51 specimens from eight introduced species recovered during archaeological excavations at the Commonwealth Block site in Melbourne, Australia. Discussion focuses on the potential for stable isotope work to identify variation in local animal husbandry practices and/or the presence of imported animals and animal products.

Stable Isotope Theory

Stable isotope analysis of human and animal remains is based on the notion that “you are what you eat” and that certain kinds of foodstuffs can have distinguishable isotopic compositions (Katzenberg 2008). Collagen is the primary component of bone protein, and may be constructed from a variety dietary constituents. However, bone collagen stable isotope values may more strongly reflect dietary protein relative to carbohydrates and lipids (Ambrose and Norr 1993; Tieszen and Fagre 1993a).

Stable carbon isotope ratios, $^{12}$C to $^{13}$C (shown as a $\delta^{13}$C‰ value relative to the PDB standard [Craig 1957]), are capable of distinguishing between consumption of foods made up of carbon routed through plants with either $C_3$ or $C_4$ photosynthetic pathways (Van der Merwe and Vogel 1978). $C_3$ and $C_4$ plants produce isotopically lighter and heavier $\delta^{13}$C values, respectively. Marine plants draw on a carbon source that is isotopically heavier (by ~7‰) than terrestrial plants and, for this reason, $\delta^{13}$C values may also help distinguish between consumption of plants from marine versus terrestrial ecosystems (Chisholm et al. 1982). Due to variations in the dissolved bicarbonates in differing upstream and local geologies (e.g. Hitchson and Krouse 1972), freshwater aquatic (lacustrine and riverine) plant $\delta^{13}$C values can vary widely.

Stable nitrogen isotope ratios, $^{14}$N to $^{15}$N (shown as a $\delta^{15}$N‰ value relative to the AIR standard [Mariotti et al. 1980]), become elevated by between 3 and 5‰ at each ascending trophic level of an ecosystem (Ambrose and DeNiro 1986; DeNiro and Epstein 1981; for review see Hedges and Reynard 2007). Based on this relationship, $\delta^{15}$N values can provide an indication of an animal’s trophic position (i.e. herbivore, omnivore, carnivore). This trophic elevation also holds for infants that feed on their mother’s breast milk, with the former having $\delta^{15}$N values that are elevated over the
latter (e.g. Schurr 1998). As food chains can be substantially longer in marine and freshwater ecosystems, in conjunction with $\delta^{13}C$, $\delta^{15}N$ values are also a useful indicator of marine, relative to terrestrial, dietary intake (Schoeninger et al. 1983). As the baseline data used in this study shows (Pate et al. 1998), it is also important to note...
that a variety of environmental factors, particularly aridity, can have an effect on the $\delta^{15}N$ values of animals (Anson 1996; Heaton and Vogel 1986; for review see Vanderklift and Ponsard 2003).

**Literature Background**

Isotopic research has been developed in Australia largely through the efforts of Donald Pate and his students (Pate 2000) working in South Australia. Advances involving ancient and modern bone, tooth, and plant materials include dietary (Hedges et al. 2007; Hobson and Collier 1984; Collier and Hobson 1987; Pate 1995b, 1997a, 1998a, b), mobility (Pate 1995a), and provenience (Pate et al. 2002) analyses of aboriginal human remains (McDonald et al. 2007); characterization of bone collagen preservation (Pate 1997b, 1998c); the construction of an isotope baseline for the region (Anson 1996, 1998; Noble 1995; Pate and Anson 2008; Pate and Krull 1998; Pate and Noble 2000; Pate and Schoeninger 1993; Pate et al. 1998); reconstructing animal seasonality (Brookman and Ambrose 2012; Fraser et al. 2008); and the use of animals to understand past climate and environments (Ayliffe and Chivas 1990; Forbes et al. 2010; Gröcke 1997a; Gröcke et al. 1997; Murphy et al. 2007; Prideaux et al. 2009; Roberts et al. 1999).

Stable isotope analysis has also been constructively applied to questions about historical-period human activities. For instance, in North America successful analyses have been conducted on human diet (Carter et al. 2004; Ellerbrok et al. 2012; Grimes 2013; Katzenberg 1991a, b; Katzenberg et al. 2000; Page 2007; Price et al. 2012; Sparks et al. 2012; Ubelaker and Owsley 2003; Vanderpool 2011; Varney 2003, 2007), mobility (e.g., Goodman et al. 2009; Schroeder et al. 2009; Schwarcz et al. 1991), weaning practices (e.g., Katzenberg and Pfeiffer 1995; Schurr 1998), and life history reconstructions more generally (Krigbaum et al. 2013; Owsley et al. 2006; Wescott et al. 2010). Similar research conducted on Australian remains has been sparse (Roberts and Pate 2012) and, to our knowledge, presently there is one published study featuring stable analyses of a historical archaeological context in Australia (Pate and Anson 2012). Pate and Anson (2012; also see Anson 2004, pp. 290–295; Taylor 2001), used stable carbon and nitrogen isotope analyses of bone collagen from 54 individuals interred at St. Mary’s Cemetery in Adelaide to reconstruct nineteenth-century dietary practices of a colonial working class population. From these analyses the authors were able to estimate the proportion of dietary protein derived from terrestrial and marine meats as well as vegetable sources and illuminate dietary differences between men and women. Based on the valuable contribution of this and similar research conducted in the Americas (above), South Africa (e.g., Cox et al. 2001; Cox and Sealy 1997; Sealy 1993), and Europe (e.g., Beaumont et al. 2013), additional stable isotope research on historical archaeology in Australia would appear to have great potential.

Although it has long been recognized that stable isotope analyses of archaeological faunal remains is a productive avenue of research (e.g., Burleigh and Brothwell 1978), analyses of animal diets, mobility, and life histories per se have received comparatively little attention. Recently, however, there has been mounting interest in gaining information from work on archaeological faunal remains (Birch 2013), especially domesticates. For instance, stable carbon and oxygen isotope analyses of tooth enamel apatite can be used to assess seasonality of birth of livestock (e.g., Balasse et al. 2012;
Frémondeau et al. 2012; Towers et al. 2011); stable nitrogen isotope analyses of tooth dentine collagen can be used to identify weaning ages (Balasse and Tresset 2002; Guiry et al. 2012c); and, in some cases, stable nitrogen isotope analyses of modern and archaeological plants can be used to identify historical field manuring and fertilizing patterns (e.g., Bogaard et al. 2007; Commissio and Nelson 2010; Kastrup et al. 2011). Additional stable isotope applications include the identification of strategies for omnivore feeding (e.g., Arge et al. 2009; Hamilton and Thomas 2012; Rawlings and Driver 2010), herbivore foddering (e.g., Fisher and Thomas 2012; Madgwick et al. 2012; Peck-Janssen 2006, pp. 63–65) and grazing (e.g., Balasse et al. 2006; Britton et al. 2008; Mulville et al. 2009), animal mobility (e.g., Millard et al. 2013; Pearson et al. 2007), and animal management practices more generally (e.g., Finucane et al. 2006; Nelson et al. 2012; Oelze et al. 2011). This research has largely focused on prehistoric archaeological contexts and few studies have taken, as their primary goal, an understanding of human-animal relations in historical New World and colonial contexts in North America or South America (Guiry et al. 2012a, b, c; Klipple 2001). To our knowledge there have been no such studies conducted in Australia.

Guiry et al. (2012a), Guiry et al. 2012c) have recently argued that there are a variety of reasons to suspect that numerous, relatively unique, human-animal relations occurring during the historical period are ideally suited for study using stable isotope techniques. For instance, new processes that may have altered animal diets and mobility (and may thus produce distinctive isotopic signatures) include: the expansion of livestock production in conjunction with other industrial processes (e.g., Guiry et al. 2012b; Rixson 2000, p. 289; Wiseman 2000, p. 8); the long-term preservation and long-distance trade of animal products (e.g., Staniforth 2000); and the introduction of more stringent meat quality regulations for animal husbandry and resulting products (e.g., Rixson 2000, p. 195).

**Historical Background of the Commonwealth Block Site**

The Commonwealth Block site (also known as “Little Lon” or “Casselden Place”) is located within Melbourne’s Central Business District and is bounded by Spring, Lonsdale, Exhibition and Little Lonsdale Streets (Fig. 2). For a century (from roughly 1850 until 1950), the

**Fig. 2** Location of the Commonwealth Block site and its components in the Central Business District of Melbourne (modified from illustration by Wei Ming from La Trobe University)
Commonwealth Block site was a central city neighborhood occupied by working-class residents together with small businesses and a few large factories. It was in the late nineteenth century that the inner-city landscape transformed from a predominately residential area to a place for commercial and industrial businesses.

From the mid-nineteenth century, Little Lon was widely regarded as a slum, an area associated with crime, prostitution, and poverty (McCarthy 1989, 1990; Ryan and Edmonds 1979). Since 1979, the Commonwealth Block site has been the focus of historical documentary research and archaeological investigations (see Lane 1995; Long et al. 2001; McCarthy 1989, 1990; Ryan and Edmonds 1979). Later assessments confirmed that Little Lon was a poor and crowded neighborhood but it was not a place of outcasts (Godden Mackay Logan et al. 2004).

The Little Lon neighborhood was occupied mostly by Europeans, especially English, Irish, and Scottish nationals. Chinese, Syrian, and other migrants started to replace European occupants in the early twentieth century. Occupations of owners and tenants included grocers, butchers, laborers, furniture manufacturers, tailors, dressmakers, boot makers, painters, tobacconists, drapers, confectioners, and coal dealers.

Faunal specimens used in this study were obtained from the 2002–03 Casselden Place Archaeological Excavation collection (site B in Fig. 2). Over 300,000 artifacts ranging from domestic ceramics to building materials were recovered, catalogued, and analyzed during and after the excavation. Results of the excavation were presented in a four-volume report (Logan et al. 2004) and later published as a special issue in the International Journal for Historical Archaeology (Murray 2006). One of the contributions to this special issue discussed the consumption and dietary patterns at Casselden Place during the late nineteenth century. Based on the faunal and shell remains sampled from specified “hotspots” of the site, the faunal analysis revealed that the Casselden Place inhabitants consumed fine cuts of meat and also cheaper varieties. Meat in the diet consisted mainly of mutton and some beef, large amounts of fish and oysters, small amounts of pork, mussels, rabbit, chicken, lamb and veal, and sometimes (although rarely) turkey and goose (Simons and Maitri 2006).

At the time of writing, Harpley is reanalyzing the Casselden Place faunal remains from all cesspits and rubbish pits (including the deposits from the butcher shop which were not originally analyzed) as part of her doctoral research. Over 7,100 fragments (about 15 % of the original faunal collection) were sampled. Preliminary findings indicated that sheep/goats (caprines) were the dominant species, followed by cows, fishes, chickens, rats, rabbits, dogs and pigs. Cat remains as well as other avian species, such as duck and goose, were also identified.

Faunal remains analyzed here have been selected based on the subsample of the collection under reanalysis by Harpley. Based on datable materials such as ceramics and coins, specimens were dated to 1850–90.

Methods

Faunal remains used in this study (n=55) were selected based on minimum number of individual counts to ensure that resulting isotopic data do not overlap. Sample selection was aimed at acquiring a maximum number of specimens from the major livestock species in a subset of the fauna collection made available to us at La Trobe University.
This resulted in the sampling of bone from a total of 15 cesspits (Fig. 3, Table 1), constructed of a variety of materials. Thus, for this preliminary project, cesspit location, type, and contents were not considered during sampling. Bone sampling and collagen extractions were conducted at the Molecular Archaeology Laboratory at La Trobe University, Australia. Bone samples of between 100 and 250 mg were cut from generally well-preserved bone using a diamond surfaced Dremel cut wheel and abraded using a dental bur to remove adhering surface contamination. Collagen extractions followed procedures laid out by Richards and Hedges (1999) and modified as seen in the work of Honch et al. (2006) and Müldner et al. (2011). Following Jørkov et al. (2007) an NaOH pretreatment was not used in this study. In brief, samples were demineralized in 0.5 M hydrochloric acid (HCl) at temperature of 4°C. The remaining collagen pseudomorphs were gelatinized on a heating block at 70°C for 48 h in water adjusted to a pH of 3 using 0.5 M HCL. Resulting gelatins were centrifuged and purified using 5-8 μm mesh Ezee® filters. Purified gelatins were then frozen and lyophilized in a freeze dryer for 48 h and sealed until isotopic analysis.

Isotope characterization was conducted at the CREATI Stable Isotope Laboratory at Memorial University of Newfoundland, Canada. Stable carbon and nitrogen isotope analyses were performed on 1 mg of collagen using a Carlo Erba NA 1500 Series II Elemental Analyzer® coupled via continuous flow to a Thermo Electron Delta V Plus® Gas Source Isotope Ratio Mass Spectrometer. Based on Protein B2155 standards (n = 5), the instrumental error (1σ) was ±0.05‰ for δ¹³C and ±0.12‰ for δ¹⁵N. Collagen integrity was investigated using three criteria (Van Klinken 1999). Stable isotope values

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**Fig. 3** The Casselden Place site at the close of excavation with property allotments plan superimposed. Allotments selected for this study are red (light gray) and cesspits are colored blue (dark gray). Square/rectangular cesspits are constructed from bluestone and circular cesspits are wooden barrel-lined (see Table 1. Modified by BH from Godden Mackay Logan et al. 2004, Figs. 1 and 4)
were considered acceptable if they derived from collagen with a yield above 2 %, percent elemental carbon and nitrogen values above 18 and 6 %, respectively, and carbon to nitrogen ratios (C:N) falling between 2.9 and 3.6 (DeNiro 1985; Van Klinken 1999).

Results and Discussion

Stable carbon and nitrogen isotope ratios along with associated collagen integrity data can be found in Table 2 and Figs. 4 and 5. Table 3 shows relevant data from a previously published stable isotope baseline for southern Australia (Pate et al. 1998; see also Anson 1996).

Collagen Quality

The vast majority of specimens sampled (n = 51 of 55) produced valid δ^13C and δ^15N data. Three pig (Sus domesticus) specimens, each the sole specimen from their respective cesspits, produced unacceptable collagen yields and were not subjected to Table 1

| Context | Cesspit Type | Lot Number | Street Number/Name | Tenant Occupations Included |
|---------|--------------|------------|--------------------|----------------------------|
| 1.400   | Bluestone    | 25C        | 22 Leichardt Street| Not available              |
| 1.401   | Bluestone    | 27         | 18 Leichardt Street| Not available              |
| 1.219   | Wooden Barrel-lined | 28A | 16 Leichardt Street | Not available |
| 2.402   | Wooden Barrel-lined | 28B | 14 Leichardt Street | Not available |
| 2.556   | Wooden Barrel-lined | 32  | 143/54 Lonsdale Street | Draper, bootmaker, furniture manufacturer, engineer, tobacconist |
| 2.069   | Wooden Barrel-lined | 35  | Little Leichardt Street/Eagle Alley | Householder, butcher |
| 2.290   | Stone-Capped | 33A        | 145/50–52 Lonsdale Street | Saloon proprietor, factory owner, butcher |
| 2.722   | Bluestone    | 33B        | 147/48 Lonsdale Street | Painter, coal dealer, dressmaker, butcher, cabinetmaker, carver and gilder, bootmaker |
| 1.230   | Bluestone    | 36A        | Little Leichardt Street | Not available              |
| 1.279   | Wooden Barrel-lined | 36A | Little Leichardt Street | Not available |
| 3.177   | Wooden Barrel-lined | 41B | Tuckers Lane/Little Leichardt Street | Dealer |
| 3.035   | Wooden Barrel-lined | 41D | Little Leichardt Street | Labourer |
| 3.040   | Wooden Barrel-lined | 41D | Little Leichardt Street | Labourer |
| 3.341   | Wooden Barrel-lined | 41D | Little Leichardt Street | Labourer |
| 1.023   | Bluestone    | 84A        | 128/45 Little Leichardt Street | Painter, agent, boarding house keeper, carpenter, wood dealer, sweep |
| Lab No.  | Cat. no. | Animal | Taxon     | Context | Element | δ\(^{13}\)C‰ | δ\(^{15}\)N‰ | Yield % | %C | %N | C:N |
|---------|----------|--------|-----------|---------|---------|----------------|---------------|---------|----|----|-----|
| MARC 1496 | LL4201   | Pig    | *Sus domesticus* | 2.069   | Mandible | -18.3          | 12.0          | 9.0     | 36.3 | 13.0 | 3.3 |
| MARC 1494 | LL88230  | Pig    | *Sus domesticus* | 1.023   | Mandible | -20.2          | 7.1           | 8.2     | 43.0 | 15.6 | 3.2 |
| MARC 1497* | LL36698  | Pig    | *Sus domesticus* | 1.230   | Ulna     | -17.2          | 11.1          | 19.7    | 43.7 | 15.8 | 3.2 |
| MARC 1498 | LL89131  | Pig    | *Sus domesticus* | 1.230   | Ulna     | -19.2          | 12.9          | 5.1     | 42.3 | 15.3 | 3.2 |
| MARC 1499 | LL19091  | Pig    | *Sus domesticus* | 2.402   | Phalange | -20.7          | 8.4           | 9.0     | 43.1 | 15.3 | 3.3 |
| MARC 1501* | LL11681  | Pig    | *Sus domesticus* | 3.341   | Long bone | -19.2          | 9.1           | 15.5    | 43.7 | 15.3 | 3.3 |
| MARC 1502 | LL23723  | Pig    | *Sus domesticus* | 3.035   | Fibula   | -21.7          | 9.4           | 15.7    | 45.4 | 16.4 | 3.2 |
| MARC 1503 | LL89785  | Pig    | *Sus domesticus* | 2.722   | Fibula   | -21.6          | 7.6           | 7.1     | 36.8 | 13.1 | 3.3 |
| MARC 1507 | LL23576  | Pig    | *Sus domesticus* | 3.040   | Vertebra | -19.1          | 9.8           | 17.1    | 45.4 | 16.0 | 3.3 |
| MARC 1512 | LL89882  | Sheep  | *Ovis aries*  | 1.230   | Humerus  | -16.9          | 5.9           | 6.1     | 30.5 | 11.1 | 3.2 |
| MARC 1553 | LL89893  | Sheep  | *Ovis aries*  | 1.230   | Humerus  | -16.6          | 5.3           | 12.3    | 42.0 | 15.0 | 3.3 |
| MARC 1510 | LL33811  | Sheep  | *Ovis aries*  | 1.023   | Tibia    | -15.8          | 7.1           | 15.2    | 45.0 | 16.4 | 3.2 |
| MARC 1508 | LL88071  | Sheep  | *Ovis aries*  | 1.023   | Tibia    | -19.4          | 8.5           | 10.3    | 43.7 | 15.6 | 3.3 |
| MARC 1509 | LL34071  | Sheep  | *Ovis aries*  | 1.023   | Tibia    | -20.8          | 8.9           | 13.4    | 45.1 | 16.3 | 3.2 |
| MARC 1513 | LL89893  | Sheep  | *Ovis aries*  | 1.230   | Humerus  | -20.7          | 7.8           | 15.7    | 43.8 | 15.8 | 3.2 |
| MARC 1511 | LL90493  | Sheep  | *Ovis aries*  | 1.023   | Tibia    | -21.1          | 7.3           | 9.0     | 42.6 | 14.6 | 3.4 |
| MARC 1495 | LL88232  | Dog    | *Canis familiaris* | 1.023   | Mandible | -18.8          | 9.2           | 11.0    | 43.9 | 15.9 | 3.2 |
| MARC 1514 | LL88284  | Dog (pup) | *Canis familiaris* | 1.401   | Femur   | -18.9          | 12.7          | 14.7    | 46.0 | 16.6 | 3.2 |
| MARC 1515 | LL89228  | Dog    | *Canis familiaris* | 1.230   | Mandible | -17.9          | 10.6          | 5.4     | 42.3 | 15.2 | 3.3 |
| MARC 1516 | LL23104  | Dog    | *Canis familiaris* | 1.400   | Mandible | -18.0          | 11.4          | 8.0     | 43.8 | 15.7 | 3.3 |
| MARC 1518 | LL88777  | Rabbit | *Oryctolagus cuniculus* | 3.177   | Maxilla  | -23.5          | 5.3           | 4.7     | 41.2 | 13.8 | 3.5 |
| MARC 1519 | LL18736  | Rabbit | *Oryctolagus cuniculus* | 3.177   | Mandible | -21.2          | 4.4           | 5.4     | 26.3 | 8.9  | 3.5 |
| MARC 1520 | LL33820  | Rabbit | *Oryctolagus cuniculus* | 1.023   | Mandible | -22.9          | 5.1           | 8.3     | 42.6 | 14.9 | 3.4 |
| Lab No. | Cat. no. | Animal | Taxon             | Context | Element      | δ¹³C‰ | δ¹⁵N‰ | Yield % | %C | %N | C:N |
|---------|----------|--------|------------------|---------|--------------|--------|--------|---------|----|----|-----|
| MARC 1521 | LL36708  | Rabbit | *Oryctolagus cuniculus* | 1.230   | Maxilla      | −21.8  | 4.3    | 6.4     | 43.8| 16.0| 3.2 |
| MARC 1523 | LL29870  | Rabbit | *Oryctolagus cuniculus* | 3.341   | Mandible    | −21.7  | 4.5    | 16.2    | 42.6| 15.4| 3.2 |
| MARC 1524 | LL89707  | Chicken | *Gallus* sp.     | 2.722   | Tarsometatarsus | −18.0 | 14.4  | 5.7     | 43.2| 15.4| 3.3 |
| MARC 1526 | LL89700  | Chicken | *Gallus* sp.     | 2.722   | Tarsometatarsus | −18.8 | 8.3   | -       | 39.4| 14.4| 3.2 |
| MARC 1530 | LL89697a | Chicken | *Gallus* sp.     | 2.722   | Tarsometatarsus | −18.8 | 9.1   | 12.8    | 43.8| 15.6| 3.3 |
| MARC 1531 | LL89697b | Chicken | *Gallus* sp.     | 2.722   | Tarsometatarsus | −18.2 | 14.6  | 8.1     | 43.4| 15.6| 3.3 |
| MARC 1532*| LL89697c | Chicken | *Gallus* sp.     | 2.722   | Tarsometatarsus | −18.7 | 8.5   | 8.5     | 36.0| 12.8| 3.3 |
| MARC 1528 | LL88653  | Chicken | *Gallus* sp.     | 2.402   | Ulna         | −20.4  | 12.6  | 13.5    | 42.9| 14.9| 3.4 |
| MARC 1527 | LL88656  | Chicken | *Gallus* sp.     | 2.402   | Ulna         | −20.3  | 12.9  | 7.5     | 40.9| 13.8| 3.5 |
| MARC 1529 | LL19105  | Chicken | *Gallus* sp.     | 2.402   | Ulna         | −19.8  | 11.8  | 16.4    | 39.9| 14.0| 3.3 |
| MARC 1534 | LL88429  | Cat    | *Felis catus*     | 1.400   | Humerus      | −18.8  | 11.5  | 8.3     | 42.7| 15.0| 3.3 |
| MARC 1536 | LL33851  | Cat    | *Felis catus*     | 1.023   | Metacarpal   | −17.6  | 11.3  | 19.5    | 43.8| 16.1| 3.2 |
| MARC 1537 | LL89132  | Cat    | *Felis catus*     | 1.230   | Ulna         | −17.3  | 10.6  | 8.4     | 42.9| 15.6| 3.2 |
| MARC 1538 | LL36728  | Rat    | *Rattus* sp.      | 1.230   | Femur        | −17.7  | 10.7  | 11.4    | 46.5| 16.9| 3.2 |
| MARC 1539 | LL90305  | Rat    | *Rattus* sp.      | 1.279   | Femur        | −18.4  | 10.4  | 10.6    | 38.7| 13.9| 3.3 |
| MARC 1540 | LL90304  | Rat    | *Rattus* sp.      | 1.279   | Femur        | −18.2  | 11.8  | 11.1    | 42.1| 14.5| 3.4 |
| MARC 1542 | LL88659  | Rat    | *Rattus* sp.      | 2.402   | Femur        | −16.9  | 8.8   | 12.7    | 43.0| 15.1| 3.3 |
| MARC 1541 | LL88658  | Rat    | *Rattus* sp.      | 2.402   | Femur        | −17.5  | 9.4   | 10.6    | 42.5| 14.7| 3.4 |
| MARC 1544 | LL19103  | Rat    | *Rattus* sp.      | 2.402   | Femur        | −18.1  | 10.4  | 13.2    | 41.6| 14.5| 3.4 |
| MARC 1545 | LL90255  | Rat    | *Rattus* sp.      | 2.402   | Femur        | −17.1  | 9.9   | 16.1    | 42.8| 15.0| 3.3 |
| MARC 1533 | LL35264  | Cow    | *Bos taurus*      | 2.722   | Maxilla      | −14.4  | 4.9   | 15.7    | 44.8| 16.3| 3.2 |
| MARC 1535 | LL35267  | Cow    | *Bos taurus*      | 2.722   | Mandible    | −17.1  | 5.4   | 2.3     | 12.4| 4.3 | 3.4 |
| MARC 1548 | LL17459  | Cow    | *Bos taurus*      | 2.556   | Rib          | −8.4   | 3.8   | 7.8     | 42.2| 15.3| 3.2 |
| Lab No.  | Cat. no. | Animal | Taxon      | Context | Element | $\delta^{13}C_\%$ | $\delta^{15}N_\%$ | Yield | %C | %N | C:N |
|----------|----------|--------|------------|---------|---------|-----------------|-----------------|-------|----|----|-----|
| MARC 1549 | LL32508  | Cow    | *Bos taurus* | 1.219   | Vertebra | −14.9           | 8.3             | 9.9   | 41.7 | 14.7 | 3.3 |
| MARC 1547 | LL12436  | Cow    | *Bos taurus* | 2.290   | T vertebra | −20.5           | 7.5             | 2.5   | 40.0 | 13.3 | 3.5 |
| MARC 1550 | LL6620   | Cow    | *Bos taurus* | 1.401   | Tibia    | −19.0           | 8.1             | 6.1   | 40.5 | 14.5 | 3.3 |
| MARC 1551 | LL23765  | Cow    | *Bos taurus* | 2.402   | Humerus  | −20.6           | 6.9             | 11.7  | 42.5 | 15.2 | 3.3 |
| MARC 1552 | LL23470  | Cow    | *Bos taurus* | 1.400   | Femur    | −20.5           | 7.2             | 5.2   | 43.0 | 15.6 | 3.2 |
isotopic measurement. Data from these samples are not presented here. All remaining collagen samples produced C:N ratios within the acceptable range of 2.9 to 3.6. Carbon and nitrogen concentrations were more variable. While most samples showed carbon

![Graph](image-url)

**Fig. 4** Stable carbon and nitrogen isotope data from faunal remains collected at the Commonwealth Block site (see Table 2). CW, Commonwealth Block Site; MG, Mount Gambier; K, Kart; P, Plumbago; I, Innamincka. Error bars show one standard deviation

![Graph](image-url)

**Fig. 5** Averaged and regrouped stable carbon and nitrogen isotope data from faunal remains collected at the Commonwealth Block site (see Table 2). Error bars show one standard deviation
and nitrogen concentrations well above their respective cut-off values, one cow (*Bos Taurus*) specimen, MARC 1535 show evidence of poor collagen integrity.

This variability in preservation is interesting in light of the variety of archeological contexts sampled, all of which were built with the same intent—refuse disposal. Samples from four separate cesspits failed to satisfy collagen integrity criteria indicating that collagen preservation can vary between cesspits at the same site. Collagen preservation can also vary within an individual cesspit deposit as evidenced by the range of carbon and nitrogen concentration values produced, for example, by samples from cesspit 2.722. The type of material used to construct the lining of a cesspit does not appear to affect preservation. All three types of cesspit construction, chisel-dressed bluestone lined pits (e.g., 2.722), wooden barrel lined pits (e.g., 3.177), and unlined pits (2.512 and 2.290), produced both valid and compromised collagen data. Overall, there does not appear to be any clear pattern underlying difference in collagen integrity between samples.

### The Isotopic Baseline

Interpretation of $\delta^{13}C$ and $\delta^{15}N$ data for the Commonwealth Block site faunal remains is aided by an extensive bone collagen stable isotope baseline compiled by Anson (1996), Anson 1998; also see Pate et al. 1998). Of particular interest are a substantial number of modern eutherian mammals (rabbits [*Oryctolagus cuniculus*], sheep [*Ovis aries*], and cattle) collected from four sites strategically selected along a north–south transect (east of the South Australia-Victoria/New South Wales boarder). These analyses provide an understanding of $\delta^{13}C$ and $\delta^{15}N$ variation within animals in different precipitation regimes (see Table 3, Fig. 1). In the temperate wet south, a climatic environment similar to that of the region surrounding the Commonwealth Block site, Anson (1996) analyzed animals from Mount Gambier and Karte. From the warmer arid north, animals were analyzed from Plumbago Station and Innamincka. Results show

### Table 3

Average stable carbon and nitrogen isotope data from modern faunal bone collagen taken from sites along a south–north (C$_3$-C$_4$ dominated) transect of the Victoria/New South Wales-South Australia boarder.

| Animal Group        | Site                              | Mean Annual Rain Fall (mm) | n=  | $\delta^{13}C^\%o$ | $\delta^{15}N^\%o$ |
|---------------------|-----------------------------------|----------------------------|-----|-------------------|------------------|
| Rabbits             | Mt. Gambier (37°56’ S, 140°47’ E) | 700–800                    | 7   | $-23.9\pm1.0$    | 4.3$\pm0.9$     |
| Domestic Herbivores | Mt. Gambier (37°56’ S, 140°47’ E) | 700–800                    | 17  | $-23.2\pm1.2$    | 8.3$\pm1.5$     |
| Rabbits             | Karte (35°56’ S, 140°42’ E)       | 300–400                    | 11  | $-23.2\pm0.8$    | 6.2$\pm0.9$     |
| Domestic Herbivores | Karte (35°56’ S, 140°42’ E)       | 300–400                    | 7   | $-21.8\pm0.8$    | 7.7$\pm0.4$     |
| Rabbits             | Plumbago (32°04’ S, 139°53’ E)    | 200–250                    | 7   | $-21.9\pm1.7$    | 12.0$\pm1.9$    |
| Domestic Herbivores | Plumbago (32°04’ S, 139°53’ E)    | 200–250                    | 8*  | $-18.9\pm2.2$    | 13.4$\pm1.1$    |
| Rabbits             | Innamincka (27°56’ S, 140°47’ E)  | 150–175                    | 18  | $-19.6\pm2.4$    | 10.6$\pm2.0$    |
| Domestic Herbivores | Innamincka (27°56’ S, 140°47’ E)  | 150–175                    | 8*  | $-16.8\pm1.5$    | 12.2$\pm1.2$    |

Standard deviations are 1σ. Domestic herbivores consist of sheep and cattle. Data except for $\delta^{13}C$ from rabbits is from Pate et al. (1998) Rabbit $\delta^{13}C$ data is unpublished from Anson (1996) and is reproduced here with his permission.
that samples from the southern sites produced systematically lower $\delta^{13}$C and $\delta^{15}$N values reflecting the dominance of C$_3$ plants and relatively low soil and foliar $\delta^{15}$N values. Animals from the warmer arid north were found to have more variable and higher $\delta^{13}$C and $\delta^{15}$N values reflecting the dominance of C$_4$ grasses and elevated soil and foliar $\delta^{15}$N values. Melbourne is roughly 400 km east of Mount Gambier and 500 km southeast of Karte and falls into a similarly C$_3$ dominated vegetation and precipitation regime (Hattersley 1983; see Fig. 1). For this reason, geographically and environmentally speaking, the stable isotope data from faunal bone collagen from the Mount Gambier and Karte sites provide the most appropriate available comparative baseline for livestock raised locally around, and consumed at, the Commonwealth Block site.

It should also be noted that stable carbon and nitrogen isotope ratios can vary on temporal scales (e.g., Van Klinken et al. 2000, pp. 41–42; Gröcke 1997b). For instance, global anthropogenic the carbon emissions from the burning of fossil fuels has depleted atmospheric $\delta^{13}$C composition by roughly 1.5‰ over the past 250 years (Marino and McElroy 1991; see also Tieszen and Fagre 1993b). However, considering the close geographical and temporal relationship between the Commonwealth Block site and Anson (1996), Anson 1998; also see Pate et al. 1998) baseline data set such isotopic variation may not significantly influence interpretations.

Herbivores

Rabbits

Rabbits were introduced to Australia in the eighteenth century and spread rapidly afterwards (Stodart and Parer 1988). For this reason, it is relatively safe to assume that faunal remains from this herbivorous eutherian species collected from mid-late nineteenth-century Commonwealth Block site contexts do not derive from imported animals and should therefore provide a local baseline for the area surrounding the Commonwealth Block site.

It is important to note that rabbit bone collagen may not reflect dietary intake in precisely the same way as larger mammals analyzed in this study. Anson’s (1996, 1998) study of stable isotope variation between Australian rabbits and other eutherian mammals (cattle and sheep) suggested that rabbits tend to produce $\delta^{15}$N values that are systematically lower (by between 1.5 to 4‰) than sheep and cattle. Cattle and sheep exhibit a foregut fermenting digestive physiology and derive a large percentage of their complete protein intake from gut microbes, which can place them as much as a trophic level above non-foregut fermenting fauna such as rabbits (see Coltrain et al. 2004). Additionally, Anson (1996, p. 98) speculates that this isotopic difference may reflect the lower metabolic rate of fossorial animals or their practice of caecotrophy. Despite this slight difference, Anson’s study clearly shows that rabbits, sheep, and cattle feeding in the same environment will share generally similar $\delta^{13}$C and $\delta^{15}$N values and, for this reason, we use archaeological rabbits captured or raised in the vicinity of the Commonwealth Block site as a local isotopic baseline for terrestrial herbivores.

Rabbits ($n=5$) from the Commonwealth Block site produced a relatively tight cluster of $\delta^{13}$C and $\delta^{15}$N values that average $-22.2\pm1.0$‰ (ranging 2.3‰) and $4.7\pm0.5$‰.
Cattle and Sheep

Cattle and sheep, on the other hand, produced an extreme range of isotope values (~13‰ for δ13C and ~5‰ for δ15N) and suggest a diverse set of dietary intake regimes. This variation could reflect: (a) tremendous variability in local animal husbandry practices (including the import of exotic fodder); (b) a sample population including some imported specimens deriving from heterogeneous origins; or (c) considerable variation in local isotope ecologies.

It appears that at least some of these specimens probably derive from animals that were locally raised. Considering expected local isotope values, it is possible to describe one group of domesticate herbivores (Group A), four sheep (MARC 1508, 1509, 1511 and 1513; mean δ13C=-20.5±0.8‰ and δ15N=8.1±0.7‰) and four cattle (MARC 1547, 1550, 1551, and 1552; mean δ13C=-20.2±0.7‰; and δ15N=7.4±0.5‰), which have statistically indistinguishable stable isotope values (One Way ANOVA, Post Hoc Bonferroni test, P>0.05). These values are consistent with a diet deriving from the same environment as rabbits from the Commonwealth Block site. In particular, together these cattle and sheep specimens (n=8) have mean δ13C (~20.3±0.7‰) and δ15N (7.8 ±0.7‰) values that are ~2 and 3% higher, respectively, than those of the Commonwealth Block site rabbits. This is similar to the offsets between rabbits and domestic herbivores observed by Anson (1996) and Pate et al. (1998) at Mount Gambier and Karte. The 2‰ difference between livestock and rabbits in δ13C is difficult to explain without detailed records of historical vegetation regimes in the Melbourne region but may, in addition to differing digestive physiologies, reflect the incorporation of marginally more C4 plant materials into sheep and cattle diets. This could result from a species-specific preference for differing fodder or habitation of regions with slightly different isotopic compositions (e.g. relatively fewer C4 grasses and forbs consumed by rabbits). Despite the offset in δ13C values between rabbits and Group A herbivores we find the most parsimonious interpretation to be that these animals represent livestock that was locally raised. If this is the case we can suggest that some of the beef and mutton consumed by residents of the Commonwealth Block site derived from animals raised in pastures in the general vicinity of the developing city and that these pastures were typically composed mainly of C3 plants with a minor presence of C4 species.

Considering the herbivorous domesticates that do not have expected local values (Group B), three sheep (MARC 1510, 1512, and 1553; mean δ13C=-16.4±0.5‰ and δ15N=6.1±0.9‰) and four cattle (MARC 1533, 1546, 1548, and 1549; mean δ13C=−13.8±3.9‰; δ15N=5.6±1.9‰), this group has isotopic signatures that are significantly different (One Way ANOVA, Post Hoc Bonferroni test, P<0.05 [significance obtains when outlier MARC 1548 is removed]) from the δ13C values of Group A specimens. The animals in Group B have been husbanded in an area or areas with a comparatively depleted δ15N baseline (relative to Group A animal) and 13C enriched plants resulting in bone collagen δ13C values between −17.6 and −8.4‰.

There are a number of possibilities that might explain these differing isotopic signatures. Higher δ13C values might be caused by substantial grazing in more arid...
regions with pastures dominated by C₄ grasses such as those found further north
towards the arid interior of the country (see Hattersley 1983). However, both wild
and domesticate herbivores from modern and archaeological faunal assemblages from
these regions show a concomitant elevation in δ¹⁵N values (see Plumbago Station and
Innamincka data in Fig. 5; Anson 1996, 1998; Pate et al. 1998) that is not observed in
the Group B individuals. Only one cow specimen (MARC 1549) produced δ¹³C and
δ¹⁵N values that might be consistent with this interpretation and it is possible that this
individual was husbanded in Australia in a more arid region.

Alternatively, Group B herbivores could have simply been raised in an area with
anomalously low soil and foliar δ¹⁵N values. Gröcke 1997b, for instance, observed
very low δ¹⁵N values in late Pleistocene fauna from Henschke Cave. These findings
were difficult to explain, however, due to the cave site’s close geographic proximity to
Mount Gambier, the area from which Anson (1996); Pate et al. 1998) obtained much
higher faunal δ¹⁵N values, similar to those of the first group of herbivorous
domesticates discussed above. In this context Gröcke 1997b argues that a later increase
in soil nitrogen isotope values has affected the region and that δ¹⁵N values of later
modern fauna reflect this change.

Another possibility is that some animals from Group B were raised partly on aquatic
or terrestrial plants from the local coastline. A diet focusing largely on low trophic level
aquatic plants could theoretically produce comparatively low δ¹⁵N and high δ¹³C
values (Balasse et al. 2005, 2006), although there is relatively little published literature
analyzing this possibility. Recent research focusing on coastal salt marsh grazing sheep,
furthermore, suggests that such animal husbandry practices (though not necessarily
focusing on aquatic plants) would result in elevated δ¹⁵N values (Britton et al. 2008). A
final potential alternative is that these animals were raised locally but were fed partly on
imported C₄ grains grown in a region with a relatively low δ¹⁵N baseline. This
suggestion, however, seems highly improbable as Australia has ample pastureland.

In the context of the early colonial port of Melbourne, we find the most parsimo-
nious interpretation to be that these specimens derived from animals that were imported
to Australia either as livestock or cured-meat, having been raised in regions with a
higher abundance of C₄ plants and lower δ¹⁵N baseline than was characteristic of the
Melbourne region.

If this is the case, the isotopic data can also begin to suggest potential origins for
certain specimens. For instance, the most extreme example comes from one cow
specimen (MARC 1548) that produced a δ¹³C value reflecting a heavy reliance on
C₄ plants such as maize or sugar cane, crops known to have figured prominently in
North American cattle husbandry at that time. Similar δ¹³C values have allowed for the
rough approximation of cattle origin in other colonial archaeological contexts (Klipple
2001). Unfortunately isotopic studies of historical livestock raised in North America
and other potential sites of origin are limited and more exploratory research is needed.

A Caveat

We also acknowledge that a diet consistent with the incorporation of resources available
from a particular environment does not provide certainty that an animal was husbanded
there. This uncertainty might be addressed in two ways. First, further analyses could
focus on additional modern and/or archaeological faunal remains that are known to have been raised locally to provide a more robust characterization of the region’s historical isotopic baseline. However, for archaeological livestock samples it can be difficult to establish the origin of a faunal specimen with complete certainty, and for modern samples, differences between contemporary and historical livestock husbandry and agricultural land management practices may complicate direct comparisons. Nonetheless, these lines of support merit investigation. Secondly, additional application of stable sulfur and oxygen as well as radiogenic strontium isotope analysis (provenance oriented isotope techniques [Bentley 2006; Nehlich et al. 2012]) to these faunal remains may allow for the identification of non-local animals and more detailed suggestions about the origin of outliers.

**Omnivores and Carnivores**

Consideration of stable isotope data from omnivores and carnivores from the Commonwealth Block site might provide further insight into the question of local versus non-local domestic herbivores. Rats (Rattus sp.), commensal omnivores, from the site would have scavenged in and around the settlement and, for this reason, produce stable isotope values that might be considered a rough averaging of domestic refuse in the vicinity. Isotopic signatures from rats (n=7) cluster relatively tightly (mean \(\delta^{13}C=-17.7\pm0.6\%o\) and \(\delta^{15}N=10.2\pm1.0\%o\)) and reflect a diet incorporating variable quantities of animal and plant protein with a dominant C_3 origin and a small contribution from of C_4 sources. Meanwhile, dogs (Canis familiaris; n=4) and cats (Felis catus; n=3) produce \(\delta^{13}C\) (−18.4±0.5‰ and −17.9±0.8‰, respectively) and \(\delta^{15}N\) (10.7±1.2‰ and 11.4±0.5‰, respectively) values that are statistically indistinguishable from those of rats (One Way ANOVA, Post Hoc Bonferroni test, \(P>0.05\)), though they fall at the higher end of the range of rat \(\delta^{15}N\) values suggesting the consumption of relatively higher amounts of animal protein. This is consistent with the carnivorous diet of cats and more omnivorous feeding of dogs.

The sheep and cattle interpreted above as deriving from local animal husbandry (Group A) plot in-between those of local rabbits and omnivores/carnivores (see Fig. 5), providing further support for the interpretation of their local origin. Similarly, those sheep and cattle (Group B) producing values outside the ‘local’ range between rabbits and omnivores/carnivores (i.e. with high \(\delta^{13}C\) and low \(\delta^{15}N\) values), represent non-local livestock, which were presumably less frequently consumed by scavengers such as rats, dogs, and cats. Given that the scavengers are likely to reflect what was available (and not particular dietary preferences) this would imply that the “non-local” livestock was less frequently available than the local. Historical records of meat prices in nineteenth-century Melbourne are limited, but this tentative evidence for relatively restricted consumption of imported, possibly preserved, meats at the Commonwealth Block might reflect the lower income of its residents. According to Timothy Augustine Coghlan (1918), a government statistician, fresh meat of all descriptions was inexpensive in Australian colonies. During the late nineteenth century, the price of beef ranged from 2½d. to 4d. per pound, mutton averaged 2½d. per pound and pork was usually sold at 6½d. per pound. However, the consumption of bacon, a cured meat, was not wide spread and relatively expensive in comparison (between 7d. and 8½d. per pound).
Remaining omnivorous livestock domesticates, pigs (n=9) and chickens (n=8) produced variable δ^{13}C (ranging ~3 and 2.5‰, respectively) and δ^{15}N (ranging ~6 and 6.5‰, respectively) values but, unlike those of some (non-local; Group B) herbivorous domesticates, these fall within the range that would be expected for animals raised in the vicinity of the Melbourne. Pigs and chickens have δ^{13}C (−19.7±1.5 and −19.1±0.9‰, respectively) values that are indicative of a predominately C₃ based diet and have δ^{15}N (9.7±2.0 and 11.5±2.6‰, respectively) values that range from a primarily vegetarian diet to one that might include a substantial intake of animal protein. If these animals were raised locally, this isotopic evidence suggests that swine and poultry husbandry practices involved the consumption (via scavenging and/or intentional feeding) of local offal, including table scraps and animal waste (i.e. unwanted entrails and body parts) from local livestock production. It is also possible, particularly in the case of two chickens (MARC 1524 and 1531) with highly elevated δ^{15}N values (14.4‰ and 14.6‰, respectively), that some of these animals were partially fed a diet consisting of marine or freshwater fish or perhaps the flesh of other chickens and livestock.

While it is unlikely that chickens would be regularly imported for immediate consumption, pigs and particularly cured-pork products were imported into the region to satisfy animal protein needs of the community (Staniforth 2000, 2007). A study (English 1990) of the remains of salt meats that were historically destined for Melbourne demonstrated that a wide variety of skeletal elements could be present in barreled pork products and, for this reason, traditional body part representation analyses of pig bone have not been able to ascertain the presence of imported pork products at the Commonwealth Block site using zooarchaeological techniques (Harpley, unpublished data). Nonetheless, it remains possible that some of these specimens reflect animals that were raised and slaughtered elsewhere and procured by the colony through international or inter/intra colonial trade. This possibility might be assessed through the further analyses of these and other specimens form historical sites in and around Melbourne using stable sulfur, oxygen, and radiogenic strontium isotope analyses in addition to δ^{13}C and δ^{15}N work. Interpretations of such data would also be aided by the additional analysis of comparative collections that include barreled salt-meat faunal remains with known origins such as those from shipwrecks (i.e. the William Salthouse [English 1990] or the Sydney Cove [Nash 2001]) or from localized sites such as industrial whaling stations (e.g., Lawrence and Tucker 2002) with well-characterized salt-meat faunal assemblages.

Significance

These preliminary findings could shed light on life for residents at the Commonwealth Block site, animal husbandry and food procurement practices in Melbourne and the surrounding region, and future methodological developments for historical archaeology and faunal analyses in Australia and abroad.

Food Procurement and Animal Husbandry at the Commonwealth Block Site

These analyses provide interesting clues about the foodways (from production, to procurement, to disposal) of some residents at the site. For example, rats produced
stable isotope data suggesting that the majority of food refuse available to scavengers had isotopic signatures consistent with the locally produced foodstuffs. This finding suggests that much of the food consumed and discarded by the Commonwealth Block site community was locally sourced. Likewise, data from local omnivores, pigs and chickens, are generally consistent with this local baseline but show more variable animal husbandry practices perhaps indicating a variety of small scale local livestock raising regimes based on household food scraps. Additional provenience oriented isotope techniques will be needed to assess this possibility.

Methodological Implications for Determining Meat Origins

This study (see also Guiry et al. 2012b; Klipple 2001; Varney 2003) suggests that in some contexts, and with varying degrees of resolution, it is possible to distinguish between imported animals and meat products and locally raised livestock—a distinction that may reflect social and economic factors such as the adequacy of local food supplies and emphases on maritime activities (Staniforth 2000, 2007). Our results have suggested that some animal products consumed at the Commonwealth Block site derive from imported livestock and/or probably, at least partly in the case of cattle (MARC 1548), from barreled salted beef. This provides additional confirmation and evidence for English’s (1990) assertion not only that barreled salt-meats from historical periods contained bones that appear in the archaeological record (e.g. Crader 1990; Gurdony 1977), but also that at least some of the salt-meat products that were bound for Port Phillip did contain bone. Additionally, a capacity to separate barreled meat elements from locally butchered remains opens the way for new zooarchaeological analyses of Australian historical faunal remains. For instance, use of additional sulfur and strontium isotope techniques to more firmly identify elements from imported animal products, may allow for an assessment of the distribution of pig and cow skeletal elements that were included in barreled salt-meat consumed by colonists. This information remains unknown but could have a wide applicability for identifying the presence or absence of barreled salt-meat at other historical archaeological sites around the globe.

Tracing Intra-Site Meat Consumption

As each cesspit is associated with particular users, who can in some cases be characterized through historical documentation (Murray and Mayne 2003; see Table 1), we can also begin to piece together who was eating what and from where. While additional in-depth analyses would be needed to fully realize this possibility, we can already point to some relationships. For instance, stable isotope signatures from chicken remains disposed of in context 2.722, a blue stone cesspit associated with a butcher (1858–72), show separate animal husbandry practices and could reflect separate sources from two different poultry producers (confirmation of this example might be made through stable sulfur isotope analysis). Such clues suggest that further, larger scale analyses of faunal remains from individual well contextualized cesspit or midden deposits could allow for relatively high resolution reconstructions of diachronic trends in meat consumption practices for small groups of people in urban settings.
Tracing Intersite Meat Provisioning

On a larger scale, the extension of these analyses in scope and design could inform understandings of socioeconomic processes in the early development of Melbourne and the surrounding region. For instance the application of stable carbon, nitrogen, and sulfur as well as radiogenic strontium isotope analyses, to a larger suite of faunal remains deriving from refuse from different urban and rural places and times that reflect more variable social and environmental circumstances (e.g., statuses, ethnic backgrounds, and activity settings) would provide an opportunity to dissect the consumption of non-local animal products across a much broader and more inclusive historical period. Such broad and yet fine grained studies are becoming more frequent (e.g., Stevens et al. 2013) and could also address equally significant aspects of trade in livestock and animal products as, from the colony’s earliest days, both Melbourne and the surrounding Port Phillip region are known to have had historically significant trading relationships (e.g., Staniforth 2000).

Conclusion

We have analyzed the stable carbon and nitrogen isotope ratios of bone collagen from 51 eutherian mammals from the historical archaeological context of the Commonwealth Block site in Melbourne, Australia. Results show tremendous diversity in livestock diets and suggest that husbandry practices for animal products consumed on the site were varied. We have argued that this evidence probably reflects the consumption of animals that were locally raised as well as some imported/non-local animals and animal products. While this preliminary data does not, for the most part, provide conclusive evidence for partial reliance on imported animal products we have suggested ways that this possibility can be further addressed and outlined how such research might advance understandings of food ways in historical Australia as well as provide an opportunity to advance and test zooarchaeological and archaeological bone chemistry techniques.

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