Sugar Monoculture, Bovid Skeletal Part Frequencies, and Stable Carbon Isotopes: Interpreting Enslaved African Diet at Brimstone Hill, St. Kitts, West Indies.

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Archaeological investigations on the eastern Caribbean Island of St. Kitts (Figure 1) have been initiated to assess the activities of enslaved Africans at Brimstone Hill Fortress. The British began building the fortress in 1690 and, except for a brief period during 1782 and 1783 when the French controlled Brimstone Hill, occupied it until the mid nineteenth century. Much of the archaeological fieldwork has focused on an area just outside of a defensive wall (designated BSH 2) on the west side of the Fortress (Schroedl 1998). According to a 1791 British military engineers map, BSH 2 was the location of a kitchen, two hospitals, and a craftsmen's building utilized by slaves or "artificers" (i.e. enslaved African craftsmen).

SUGAR MONOCULTURE IN THE BRITISH WEST INDIES

Historic accounts indicate that during the late seventeenth and eighteenth centuries the growing of sugarcane for export of sugar, molasses and rum was extremely important in the British West Indies with some islands becoming engaged in sugar monoculture. As early as 1647 Richard Vines wrote that "Men are so intent upon planting sugar that they had rather buy foode at very deare rates than produce it by labour, so infinite is the profitt of sugar works after once accomplished" (Hutchinson 1769:222). Between 1771 and 1775, 97 percent of the value of all exports from St. Kitts was from sugar and rum (Sheridan 1974:160). Land set aside for subsistence agriculture was generally restricted to poor mountain land and "gutsides" on which slaves were also expected to raise small

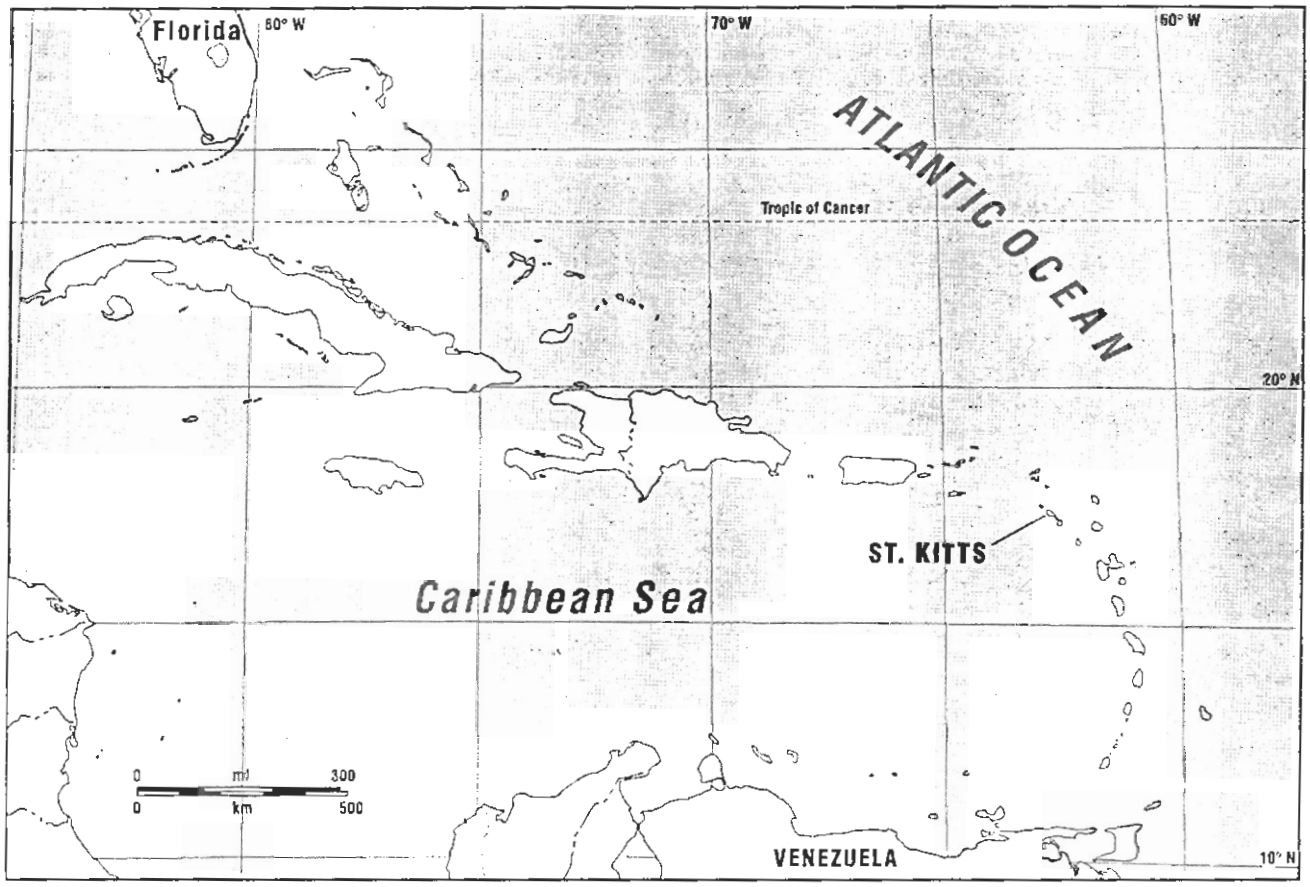

Fig. 1
Location of St. Kitts in the eastern Caribbean Sea

livestock to contribute to their own upkeep (Goveia 1965:136,137). However, so little attention was afforded this activity that in 1793 St. Kitts enacted a law requiring planters to set aside sufficient land to feed their slaves.

Notwithstanding, much of the meat for slaves was imported from England and North America during the late eighteenth centuries. In 1793 slave owners on St. Kitts were required to provide each slave a weekly allotment of "... one pound and one quarter of herring, shad, mackarel, or other salt provisions, or double the quantity of fresh fish or other fresh provisions ..." (Edwards 1819:178).

Cattle were extremely important to the sugar plantations. They were not only a source of food, but more importantly they provided power to turn cane mills and manure with which to fertilize cane fields. Planters on St. Kitts, in particular, were known for manuring their fields. In his "Historical Geography of St. Kitts and Nevis", Merrill (1958:76) notes that "By comparison with other sugar islands in the West Indies, it would appear that both St. Kitts and, to a lesser degree, Nevis, were efficient and heavy producers of sugar under slavery. The main reason why this was the case were attention to manuring, and intensive cultivation of the cane land." Often cattle were kept penned in small enclosures within the cane fields to make manuring more efficient. "In crop time the penned cattle were fed cane tops, but at other seasons they were supplied with grass" (Sheridan 1974:160). According to Thomas Ramsay who lived on St. Kitts between 1760 and 1780 collecting grass, especially in periods of severe drought, was "the greatest hardship that a slave endured, and the most frequent cause of his running away" (Ramsay 1784:73, 74).

Historical evidence relating to how the British Military organized and maintained enslaved Africans at Brimstone Hill is incomplete. The St. Kitts colonial government had responsibility to provide labor for construction and maintenance activities of military installations and plantation owners were obliged to provide the necessary slaves (Cox 1984, Goveia 1965). Some sources indicate that the military was then responsible for providing provisions for the slaves (Aspinall 1915:253, Buckley 1979:187). In some instances slaves may have actually been attached to the British Military.

ARCHAEOLOGY IN ENSLAVED AFRICAN CONTEXTS

Excavations in enslaved African contexts at BSH 2 have produced domestic and military objects of obvious British origin, Afro-Caribbean pottery, and British manufactured ceramics with geometric patterns scratched on the bases of vessels; similar designs (e.g. cosmograms) are documented in Africa and North American enslaved African contexts (Ferguson 1992). Temporally diagnostic artifacts predominantly date to the late eighteenth century.

Just over twenty cubic meters of deposits were hand excavated during the 1996 and 1997 field seasons, mostly with trowels and dustpans, and were dry-screened through one-quarter inch (6.4mm) hardware cloth. Recovered faunal remains were well preserved and even included small, delicate, fish scales. Animal bones were separated from other classes of artifacts in the field laboratory and transported to the University of Tennessee's zooarchaeology laboratory for identification.

Faunal remains from BSH 2 include 6222 animal bones of which 20 percent are identifiable to a taxonomic level below class. Over 80 percent of the identifiable bones

Table 1

Vertebrate Remains (NISP) from the 1996/1997 Excavations at BSH 2*

Taxa	Number	Percent
MAMMALIA		
Sus scrofa (pig)	457	37
Bos taurus (cattle)	365	30
Caprine (sheep/goat)	142	12
Ovis aries (sheep)	11	1
Capra hircus (goat)	8	1
Other mammals	57	5
Total Mammals	**1040**	**86**
OSTEICHTHYES Bony fish	**90**	7
REPTILIA Turtles/ snakes/lizards	**88**	7
AVES Birds	**12**	**1**
TOTAL IDENTIFIED SPECIMENS	**1230**	**101**

* Bone artifact manufacturing debris not included.

are domestic pigs, cattle, sheep and goats (Table1). The "Other Mammals" in Table 1 include both brown and black rat, dog, cat, rabbit, and horse or donkey. Fish and reptile each constitute an additional seven percent; fish include both local, tropical, taxa and extralimital cod fish from the North Atlantic, while reptile remains are mostly from sea turtles that were used extensively in the manufacture of bone artifacts (Klippel and Schroedl 1999). Birds, mostly chickens, only make up one percent of the assemblage. Nearly half of the identifiable

animal bones are those of bovids and will be the focus of the following consideration of enslaved African diet at BSH 2.

Bovid Remains from Slave Contexts

Food utility studies conducted on bovids (e.g. Binford 1978, Emerson 1990) show that lower limbs and, to a lesser extent, heads have relatively low nutritional value (low meat utility) while axial and upper limb portions are much higher in potential human nutrition (high meat utility). Roughly 50 percent of the bones in the bovid skeleton (i.e. cattle, sheep, goat) reflect low utility portions when the head (i.e. skulls, mandibles, hyoids, and teeth) and lower limbs (carpals, tarsals, sesamoids, metapodials, and phalanges) are collapsed into a low utility category. Axial (vertebrae, ribs, scapulae, and pelves) and upper limbs (humeri, radii, ulnea, femora, tibiae, lateral mallcoli, and patellae) then combine to form a high utility category (Table 2).

Ninety percent of the cattle bones from BSH 2 are high utility (Figure 2). This contrasts sharply with bone of caprines that are predominantly low utility (58 percent). The relatively even proportions of high and low utility caprine bones suggest that sheep and goats were slaughtered at or near Brimstone Hill and not transported appreciable distances as carcass parts or preserved meat.

There are at least two potential explanations for the high utility beef food refuse in slave contexts at Brimstone Hill: 1) The British Military was provisioning slaves with high utility portions of locally raised cattle that were butchered elsewhere on the Island where many of the low utility portions were discarded as offal, or 2) slaves were provisioned with at least some barreled beef shipped from England or North America to

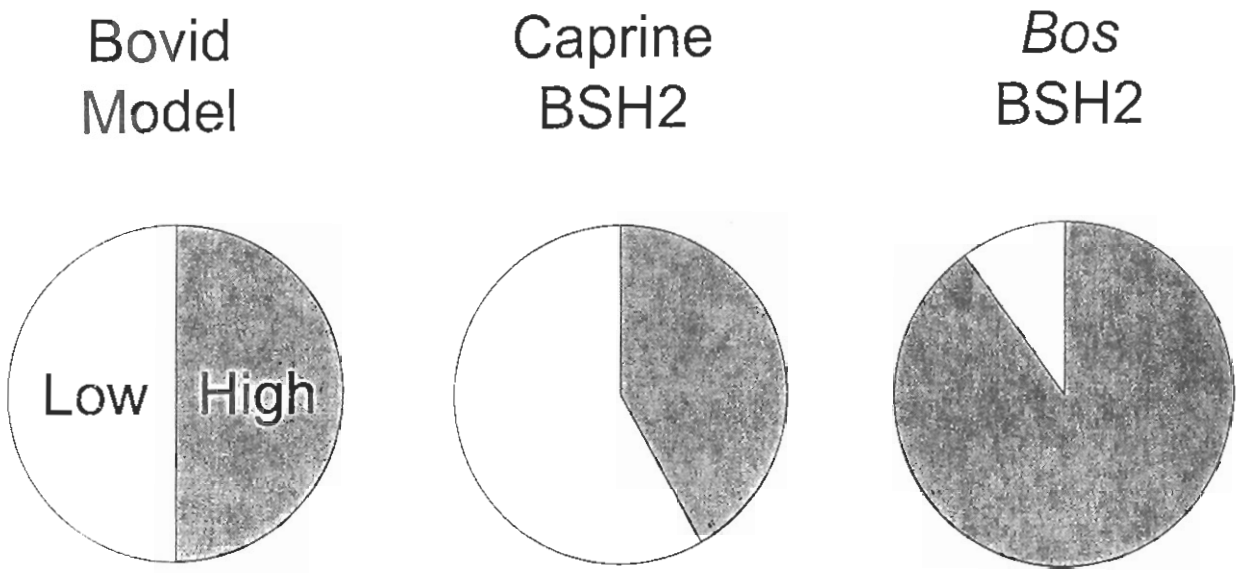

Figure 2. Skeletal part frequencies reflecting low and high utility portions of a typical bovid (Model), and bones from sheep/goat (Caprine), and cattle (Bos) from BSH2.

Table 2

Bovid Skeletal Part Frequencies

Taxon/ Portion	Typical Skeleton #	Typical Skeleton %	BSH 2 #	BSH 2 %
Cattle				
head	36	19	28	8
foot	62	32	9	2
axial	83	43	283	78
upper limb	14	7	45	12
Total	**195**	**101**	**365**	**100**
Caprines				
head	36	19	69	42
foot	62	32	25	16
axial	83	43	14	9
upper limb	14	7	53	33
Total	**195**	**101**	**161**	**100**

St. Kitts in response to sugar monoculture on the Island. According to this latter scenario, barreled beef would not likely contain low utility portions due to the high "cost" of shipping. While this second alternative is intuitively the more likely, a number of sources (e.g. Clemen 1923:115; Balkwill and Cumbaa 1987:19; Deslauriers and Rioux 1982:74; Grant 1853:278, 279) indicate that cattle marrow bones (i.e. long bones) were not included in barrels of salt beef because they caused the meat to spoil. If this is true, barreled salt beef can not account for many of the high utility cattle bones in slave contexts at Brimstone Hill.

Assessing the Origins of Bovid Remains from Brimstone Hill

Several methods were considered in an attempt to determine if some of the cattle bones from slave context at Brimstone Hill had been imported from England or North America as preserved meat (e.g. butchering patterns reflecting institutionalized processing, macroscopic alteration of bone due to preservatives [e.g. Angus and Falk 1986:39], chemical analyses to detect sodium or saltpeter, and stable isotope analyses). For varying reasons all except stable isotopes were fairly quickly abandoned.

Analyses of stable isotopes in bone collagen has been widely used to assess past human diets (Hare 1980) as well as those of other animals (see, for example, references in Koch et al. 1994, Schoeninger and Moore 1992, Tieszen 1991, and van der Merwe 1982). Stable carbon isotopes, in particular, have the potential of providing a credible means of assessing the origins the cattle remains from Brimstone Hill because of the tropical setting of St. Kitts and the food habits of cattle.

Stable Carbon Isotopes

Cool temperate climates generally enhance photosynthesis in grasses with C3 pathways while C4 grasses have a decided competitive advantage in areas of high temperature and high light intensity. As a result, grasses found in tropical and subtropical areas are dominantly C4 while those in cool temperate areas are C3 (Chazdon 1978, Collins and Jones 1985, Teeri and Stowe 1976). This dichotomy does not extend to trees and shrubs that generally have C3 pathways even in tropical and subtropical areas (Boutton 1991: 177, Mooney et al. 1989:137).

The enzyme (i.e. ribulose bisphosphate [RuBP] carboxylase) that converts CO_2 into plant carbon in C3 plants discriminates against $^{13}CO_2$, while the enzyme (i.e. phosphoenol pyruvate [PEP] carboxylase) that reduces CO_2 to plant carbon in C4 plants does not. This results in plants with the two different photosynthetic pathways (i.e. C3 vs. C4) having distinct, nonoverlaping, $^{13}C/^{12}C$ ratios that are generally expressed as $\delta^{13}C$ ‰. Mean $\delta^{13}C$ values for C3 plants are usually cited as being between –28‰ and –26‰ and those for C4 plants between –14‰ and –12‰. Ranges for the former are between –38‰ and –22‰ while those for C4 plants are between –21‰ and –9‰ (Tieszen 1991:229).

Delta ^{13}C values in plants are transferred to animals that consume them. During this transfer, $\delta^{13}C$ is enriched. Collagen in bones of ungulates such as cattle, sheep and goats is enriched in $\delta^{13}C$ by ca. 5‰ (Chisholm et al. 1985:197; Schoeninger and Moore 1992: 259; Sullivan and Krueger 1981; Tieszen 1991:240) and is generally thought to reflect the diet of mature animals over a substantial portion of their lives (Koch et al 1994:65). DeNiro and Schoeninger (1983) have shown that there are not significant difference in $\delta^{13}C$ values of different bones of given animals. Further, and of importance for the problem being addressed here, DeNiro et al. (1985) have shown that heating bone, such as roasting or boiling, does not significantly alter $\delta^{13}C$ values.

Free ranging herbivores of the family Bovidae consume grasses as well as leaves from shrubs and trees but the proportions consumed are largely species dependent. Goats, for example, have been characterized as browsers that consume leaves from shrubs and trees while cattle are grazers that dominantly feed on grasses. Sheep are mixed feeders that utilize both leaves from woody plants and grasses (Hafez et al. 1969:341, Levy

1992:70, Redding 1992:102, van der Merwe 1982:604). If these characterizations of bovid food habits are generally correct, it should be possible to differentiate bones from these taxa raised in tropical areas on the basis of their $\delta^{13}C$ values. Cattle bones will reflect consumption of tropical C4 grasses and have less negative $\delta^{13}C$ values. Goats should generally reflect browse on leaves from C3 shrubs and trees that have relatively more negative $\delta^{13}C$ values, while sheep should reflect a mixture of browsing and grazing and have intermediate $\delta^{13}C$ values. If, on the other hand, cattle were raised in England or eastern North America and then shipped to Brimstone Hill as salt beef, their bones should have $\delta^{13}C$ values that reflect consumption of temperate C3 grasses and have relatively more negative $\delta^{13}C$ values.

Stable Carbon Isotopes from Brimstone Hill Bovid Remains

Bovid bones that were included among the high utility elements in the analysis of skeletal part frequencies were chosen for stable isotope analyses. Nine distal humeri and one thoracic vertebra were subjected to stable carbon analysis by Beta Analytic Inc. and M.J. Schoeninger's Paleodiet Lab at the University of Wisconsin. All of the specimens were photographed and the seven that were sufficiently intact, were measured using standard measurements recommended by von den Driesch (1976). The distal epiphyses of both caprines were fully fused suggesting ages of over 10 months (Silver 1963:252). Cattle distal humeri epiphyses were also fused indicating they were in excess of 18 months of age (Silver 1963:252). Cortical bone from above the epicondyles was detached from distal humeri and submitted for analysis.

Distal humeri are among the more reliable of caprine bones for distinguishing sheep and goat remains (Bossneck 1969:340-341). One left goat and one right sheep distal humeri from 18th century slave context were analyzed. Three left and one right distal humeri from 18th century cattle were also analyzed. Measurements taken on these specimens indicate that all four were from different animals. One right humerus lateral diaphysis fragment and one thoracic vertebra fragment of *Bos* were also analyzed; neither were sufficiently intact to measure nor was it possible to determine if they belonged to one of the other four cattle. One modern right distal humerus with fused epiphysis from a cow that had died within the past year (Behrensmeyer 1978:157) in a field at the base of Brimstone Hill was also analyzed.

The $\delta^{13}C$ values of bovid bone collagen from Brimstone Hill show considerable variation in the plants utilized by animals whose remains were recovered from late 18th century slave contexts (Table 3). The modern cow *(B.t.#1)* and two of the 18th century cattle *(B.t.#3, B.t.#7)* must have had access to ample C4 grasses while four of the 18th century cattle (*B.t.#2*, *B.t.#4*, *B.t.#5*, and *B.t.#6*) were probably raised on vegetation with a C3 pathway. The 18th century sheep and goat bones reflect foraging on both C3 and C4 plants (Table 3).

Discussion of Stable Carbon Isotopes in Bovid Remains from BSH 2

Modern bone collagen can not be compared directly with pre industrial revolution collagen because of our accelerated use of fossil fuels (Keeling et al. 1979:122). Investigations by Cerling (1999:352) suggest that $\delta^{13}C$ has changed globally by 1‰ to 2‰ during this period and in a recent study Cerling et al. (1997:154) use a $\delta^{13}C$

Table 3

Carbon $^{13}C/^{12}C$ ratios (‰) of bovid bone collagen from Brimstone Hill.

Sample #	Species	Element	Period	Lab	$\delta^{13}C$
B.t. # 1	*Bos taurus*	humerus	modern	Beta	-11.7
B.t. # 2	*Bos taurus*	humerus	18th century	Beta	-22.3
B.t. # 3	*Bos taurus*	vertebra	18th century	Beta	-10.1
B.t. # 4	*Bos taurus*	humerus	18th century	Wisconsin	-15.62
B.t. # 5	*Bos taurus*	humerus	18th century	Wisconsin	-15.26
B.t. # 6	*Bos taurus*	humerus	18th century	Wisconsin	-21.12
B.t. # 7	*Bos taurus*	humerus	18th century	Wisconsin	-10.97
C.h. # 1	*Capra hircus*	humerus	18th century	Wisconsin	-15.38
O.a. # 2	*Ovis aries*	humerus	18th century	Beta	-14.9

enrichment correction of 1.5‰ for fossil mammals (also see Heaton 1999:645 [1.5 ‰]). This correction value has been applied to the 18th century bone samples from Brimstone Hill to facilitate a comparison with modern materials (i.e. *B.t.* # 1 as well as C3 and C4 plants). In addition, as already noted above, bone collagen is enriched in ungulates by ca. 5‰ during the transfer from plants to bone collagen. As a result, if modern cattle were grazed entirely on C4 plants with a $\delta^{13}C$ of –13.9 (e.g. sugarcane) their bone collagen should yield $\delta^{13}C$ values of –8.9. If 18th century cattle were fed only sugarcane leaves their bone collagen should yield $\delta^{13}C$ values closer to –7.4. Clearly, none of the bovids listed in Table 3 lived entirely on sugarcane. However, the modern cow (*B.t.*#1) and two

of the 18th century specimens (*B.t.*#3 and *B.t.*# 7) were from animals that had fed extensively on C4 grasses and probably represent locally raised cattle (Figure 3).

The remaining four cattle appear to have been raised on C3 plants. Two of the cattle (*B.t.*#2 and *B.t.*#6) fed almost entirely on C3 grasses which indicates they were raised in a more northern, temperate, climate. According to De Voe (1867:28) such animals produced poor quality barreled beef. "It appears to me, as soon as the salt touches 'grass-fed beef' it draws back, shrinks into a smaller compass, and changes to a dark color, as if there was not firmness or solidity to resist the action of the salt; and when boiled, especially if salted a long time, will shrink very much, leaving it tasteless, juiceless, without heart or substance, and when cut, of a dark color. 'Stall-fed beef' on the contrary, ... has the appearance (when properly cured) of being firmer, brighter, plumper, or has a swelled look, as if the well-mixed fat protected the lean parts of the flesh." Historic accounts (e.g. Clemen 1923:117, De Voe 1867:29, and Innis 1940:162, Kurlansky 1997:81, Walsh 1982:36) suggest that poor quality meat was routinely shipped to the West Indies to provision slaves. Such accounts are congruent with finding "grass-fed" salt beef in enslaved African contexts at Brimstone Hill.

The remaining cattle bones (*B.t.*#4 and *B.t.*#5) also appear to be from animals that had fed predominantly on C3 plants. If they were raised on C3 grasses and "stall-fed" corn (a C4 plant) for a several months prior to slaughter one would expect less negative $\delta^{13}C$ values. According to De Voe (1867), such animals had the potential of producing a superior quality salt beef and may represent provisions originally designated for military consumption. They could also be from cattle that had access to corn fodder. In the northeastern United States it was not uncommon to store shocked corn in barns where

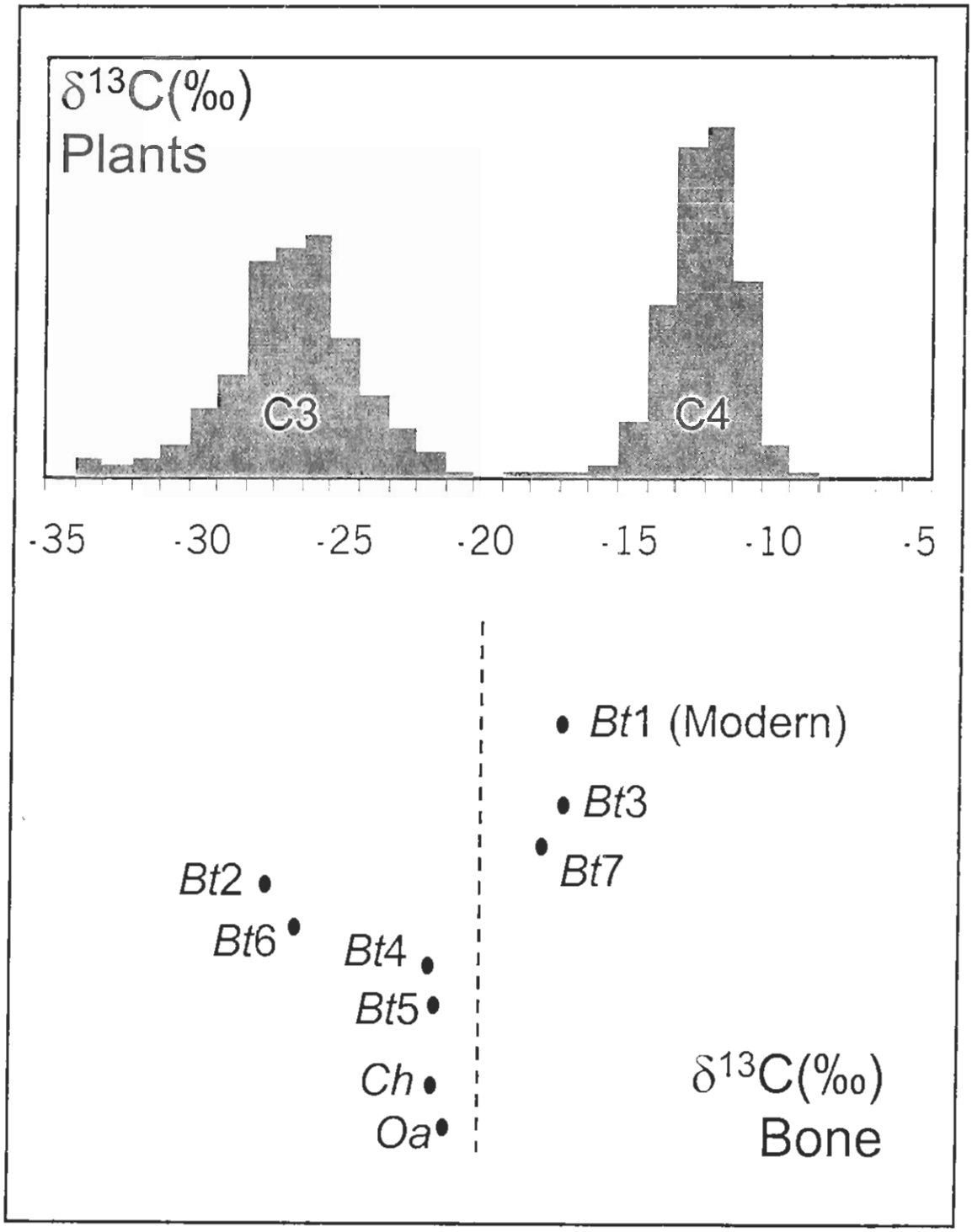

Figure 3. Delta ^{13}C values for plants (after O'Leary 1988) and bovid bones from Brimstone Hill. (*Bt, Bos taurus; Ch, Capra hircus;* and *Oa, Ovis aries*).

ears were removed, primarily for hog feed, and the stocks fed to cattle throughout the long winter months. In areas of less severe winter conditions "The corn was shocked in the field following the Virginia custom .... The cattlemen built no barns. They wintered their two-year-olds out of doors on shocked corn, put them on bluegrass in the spring and summer, and then stuffed them with corn until February, when the drive to market began" (Henlein 1959:6). These markets were typically the larger cities along the East Coast of the United States that had resumed considerable export of beef and pork, as well as livestock, to the West Indies by the 1790s (Thompson 1973:71, 73). If corn stalks, alone, are responsible for the less negative $\delta^{13}C$ values in *B.t.*#4 and *B.t.*#5 then a superior quality salt beef is not indicated. Corn stocks quickly loose nutritional value for cattle as the grain ripens (Klopfenstein 1981:40) and harvested stocks, while potentially adequate as a maintenance ration, would certainly not have served to fatten cattle.

Some corn in the diets of European cattle could also be responsible for the δ^{13} C values in *B.t.*#4 and *B.t.*#5. Corn was fairly widespread as a forage crop in Europe by the late 1700s (Young 1794) and some sources suggest that northern flint corn was 'prevalent in England' as early as 1640 (Bunting 1978:6).

The two 18th century caprine bones had $\delta^{13}C$ values consistent with having been raised on St. Kitts. Both reflect access to tropical grasses and leaves from woody shrubs or trees. While the sheep matches our expectations of mixed feeding by free ranging animals, the goat appears to have consumed more C4 plants than expected. However, in an area devoted to sugar monoculture, it is not unreasonable to assume that goats would have had access to cane harvest residue.

SUMMARY

Skeletal part frequencies of bovid remains recovered from slave context at Brimstone Hill indicate that sheep and goats were raised locally, but that beef may have been transported to the Island as barreled meat. Stable carbon isotopes confirm these interpretations; sheep and goat remains have carbon isotopes consistent with having been raised on St. Kitts while beef bones have isotopes indicating some of the cattle were raised in a temperate climate. Barreled beef, then, can account for the large numbers of high utility cattle bones in slave contexts.

Although a fair number of historic sources indicate that barreled beef was not shipped with marrow bones, there is clear evidence from Brimstone Hill that long bones were included with provisions shipped to the British West Indies during the late eighteenth century. This may be a reflection of the times when, under sugar monoculture, enslaved Africans were often provisioned with inferior quality meat from more northern latitudes.

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