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REGIONAL VARIATION IN THE PATTERN OF MAIZE ADOPTION AND USE IN FLORIDA AND GEORGIA

Dale L. Hutchinson, Clark Spencer Larsen, Margaret J. Schoeninger, Lynette Norr

Dietary reconstruction using carbon and nitrogen stable isotopes from archaeological human bone samples from coastal Georgia and northern and Gulf Coast Florida dating between 400 B.C. and A.D. 1700 serves to illustrate the complexity of the agricultural transition in that region. Isotope analysis of 185 collagen samples drawn from early prehistoric, late prehistoric, and contact-period mortuary sites encompasses two major adaptive shifts in the region, namely the adoption of maize agriculture in late prehistory and the increased emphasis on maize during the mission period. Prior to European contact—and especially before the establishment of Spanish missions among the Guale, Yamasee, Timucua, and Apalachee tribal groups—diet was strongly influenced by local environmental factors. Before contact, coastal and inland populations had different patterns of food consumption, as did populations living in Georgia and Florida. Coastal populations consumed more marine and less terrestrial foods than inland populations. In general, maize was adopted during the eleventh century A.D. by virtually all Georgia populations. However, with the exception of the Lake Jackson site, a major Mississippian center in northern Florida, Florida populations show little use of maize before contact. Following European contact, maize became widespread, regardless of location or habitat within the broad region of Spanish Florida. Missionization appears to have been an important factor in the convergence of native diets toward agriculture and away from foraging. This increased emphasis on maize contributed to a decline in quality of life for native populations.

La reconstrucción dietética usando carbón e isótopos estables provenientes de muestras arqueológicas de huesos humanos de la costa de Georgia, y el norte y Golfo de Florida datados entre 400 a.C. y 1700 d.C., sirve para ilustrar la complejidad de la transición agricultural en esa región. Análisis isotópicos de 185 muestras de colágeno extraidos de sitios mortuarios correspondientes a los períodos prehistóricos tempranos, prehistóricos tardíos, y contacto incluyen dos cambios adaptativos mayores en la región, especificamente la adopción de la agricultura del maíz en el período prehistórico tardío y el énfasis en el incremento del maíz durante el período de las misiones. Antes del contacto europeo, y especialmente con anterioridad al establecimiento de las misiones españolas entre las tribus de los Guales, Yamasee, Timucua, y Apalachee, la dieta fue influenciada fuertemente por factores ambientales locales. Antes del contacto, las poblaciones costeñas y del interior tenían patrones diferentes con respecto al consumo de alimentos, así como también las residentes en Georgia y Florida. Las poblaciones costeñas consumieron mayor cantidad de alimentos marinos y menor cantidad de alimentos terrestres que las poblaciones del interior. En general, el maíz fué adoptado en el siglo XI de nuestra era por casi todas las poblaciones de Georgia. Sin embargo, con la excepción del sito del Lago Jackson que es un centro mayor del Misisipí en el norte de Florida, las poblaciones de Florida antes del contacto muestran un escaso uso del maíz. Después del contacto europeo, se enfatizó y diseminó el uso del maíz, indiferentemente de la localidad o habitación dentro de la amplia región española de Florida. Parece que el proceso misionización fue un factor importante en la convergencia de las dietas nativas en la agricultura y declinamiento de la caza, pesca, y recolección. Tal incremento en el énfasis de maíz contribuyó al decaimiento en la calidad de vida de las poblaciones nativas después del arribo de los europeos.

In eastern North America, archaeological and osteological evidence indicates that an increased reliance on maize began between A.D. 800 and 1000 (Bender et al. 1981; Dunn 1981; Jeffries et al. 1996; Johannessen 1984, 1993; Johannessen and Whalley 1988; Moore 1985; Scarry 1993a, 1993b; Smith 1986; van der Merwe and Vogel 1978; Vogel and van der Merwe 1977; Watson 1989; Wymer 1987; Yarnell and Black 1985). Some have suggested that coastal zones in the American Southeast experienced differences in both the timing and influence of maize horticulture

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as compared to interior mainland regions (Reitz 1985, 1988). Furthermore, the available archaeological evidence suggests that maize was minimally utilized in central and southern Florida before the arrival of Europeans (Johnson 1990; Newsom 1987; Newsom and Quitmyer 1992).

There is now extensive carbon and nitrogen stable isotope data for prehistoric humans from eastern North America (Buikstra 1992; Buikstra and Milner 1991; Buikstra et al. 1988; Katzenberg et al. 1995; Keegan 1987; Little and Schoeninger 1995; Lynott et al. 1986; Schoeninger et al. 1996; Schurr and Redmond 1991) and more specifically for coastal Georgia and Florida (Hutchinson and Norr 1994; Larsen, Schoeninger, van der Merwe, Moore, and Lee-Thorpe 1992; Schoeninger et al. 1990; Tuross et al. 1994). Larsen and coworkers (Larsen, Schoeninger, van der Merwe, Moore, and Lee-Thorpe 1992; Schoeninger et al. 1990) were able to document stability and change in diet based on stable isotopes for native populations in coastal Georgia during a 2,500-year period that encompassed the transition to agriculture, the arrival of Europeans, and the establishment of Spanish missions. In their analyses, they demonstrated a trend toward increased maize consumption beginning approximately A.D. 1100, which was accentuated during the mission period (A.D. 1600–1700). Associated with a diet increasingly focused on maize was a concomitant decrease in the use of marine resources. Hutchinson and Norr (1991, 1994) examined the role of maize in the diet of the protohistoric Tatham Mound population from central Gulf Coast Florida made up of late prehistoric and early historic individuals. Their analysis indicated that the diet included limited maize and abundant lacustrine and riverine resources. The isotopic results suggest little change in dietary focus between A.D. 1200 and 1550.

These previous studies addressed specific hypotheses within local regions. Although the local regions are all in the predominantly subtropical region encompassing Florida and Georgia, ecological variations are undoubtedly important in dietary selection. The environmental setting of this large region is diverse, although some general characteristics can be highlighted. The Georgia and Florida marsh and barrier islands extend in a chain along the Atlantic coast and are populated by subtropical flora and fauna. Primary plant communities are maritime oak and pine forests. Plant and animal remains recovered from Deptford-period sites in Georgia dating between 400 B.C. and A.D. 1000 indicate that native populations relied heavily on the estuarine, marine, and terrestrial resources available on the marsh and barrier islands as well as the adjacent mainland. For example, data from Minim Island, South Carolina (Reitz 1988), and Cumberland Island, Georgia (Milanich 1980), indicate that white-tail deer (*Odocoileus virginiana*) are usually the most predominant terrestrial mammal, while marine fishes, shellfish such as oyster (*Crassostrea virginica*) and clam (*Mercenaria* spp.), and freshwater fish dominate the marine faunal assemblages. Floral remains found from this time period include a variety of wild plants but no domesticated species (Reitz 1988). The available evidence for settlement patterns and the location, reconstructed size, and population density of habitation sites indicate that these populations were generally small and transitory (Larsen et al. 1998).

The northern portion of Florida is characterized by upland and flatland pine forests and hardwood hammocks broken by rivers, lakes, and swamps (Myers and Ewel 1990). Well-drained loamy soils are plentiful in the northwestern and north-central portions of the state; today these areas are primarily used for agriculture (Brown et al. 1990). After A.D. 600, the Florida Alachua people appear to have relied on a mixed hunting, gathering, and farming subsistence strategy. Evidence for farming, however, is confined to impressions of corncobs on ceramic vessels; charred kernels and cobs have only been recovered from one late Precolumbian–early Colonial site in the region (Milanich 1994:339). Evidence for other plant use is also minimal with only palm berries (*Sabal palmetto*), hickory nuts (*Carya* sp.), and acorns (*Quercus* sp.) recovered from archaeological contexts. Deer, squirrel (*Sciurus* spp.), and freshwater fish including catfish (Ictaluridae), gar (*Lepisosteus* sp.), bowfin (*Amia calva*), and sunfish (*Lepomis* sp.) are among the common animal remains found in archaeological contexts (Milanich 1994:338–339).

About A.D. 1000–1200, habitation sites became increasingly larger and greater in number in many parts of the study area. At Irene Mound and some other locations, these sites assumed the mound and plaza configuration emblematic of the Mississippian cultural tradition (Anderson 1994; Crook 1984; DePratter 1991; Smith 1986, 1990). Many southeastern sites contain abundant remains of domesticated plants, especially maize, beans, and squash, during this time period (Dunn 1981; Jeffries et al. 1996; Johannessen 1984, 1993; Johannessen and Whalley 1988; Scarry 1993a, 1993b, 1993c; Smith 1992). Plant domesticates are presumed to have accompanied this complex shift in behaviors, but domesticated plant remains have been found in only some late prehistoric sites in Florida and Georgia (Reitz 1988; Smith 1992). For instance, analysis of plant and animal remains from the Georgia coast indicates that before A.D. 1150 populations in this region relied on the same suite of dietary staples as in the previous period.

In the northwestern corner of the Florida panhandle, the historic tribal area of the Apalachee and the area of the Fort Walton culture (A.D. 1000–1550) (Hann 1988; Milanich 1994; Scarry 1990a), remains of maize (*Zea mays*) and beans (*Phaseolus vulgaris*) are common (Alexander 1984; Mikell 1990; Scarry 1993c). Common nondomesticates at Fort Walton sites are hickory nuts, acorns, persimmon (*Diospyros virginiana*), maypop (*Passiflora incarnata*), and wild cherry (*Prunus* sp.). Animals that appear to have been eaten include white-tail deer and locally available fish, such as gar, mullet (*Mugil* spp.), sheepshead (*Archosargus* sp.), drum (Sciaenidae), and saltwater catfish (Ariidae). Farther south in Florida, however, evidence for maize is absent. In Citrus County, for instance, in an analysis of two column samples and two features from the Bayonet Field site (8CI197) the most common faunal remains were fish, especially gar, freshwater catfish (Ictaluridae), sunfish, and several species of turtles (Fitzgerald 1987). One cucurbit seed was found at the site, although it was found in the contact-period stratum (Mitchem 1989).

Five historic tribal groups were present in the study area when the Spanish arrived: Guale (Georgia coast), Yamasee (North Atlantic coastal Florida), Timucua (north Florida), Apalachee (panhandle Florida), and Ocale (central Gulf Coast Florida). The first documented Spanish explorations began in 1519, and in 1565 the Spanish established the first successful permanent settlement at St. Augustine, Florida (Hann 1988, 1996). After the founding of this settlement, the Spanish established a series of Roman Catholic missions along the Atlantic coast in Georgia and Florida and a series of missions extending from east to west in northern Florida (Bushnell 1994; Hann 1988, 1990, 1996; Jones et al. 1991; Marrinan 1993; McEwan 1993; Scarry 1990a, 1990b, 1994; Shapiro and McEwan 1992; Weisman 1992, 1993; Willey 1982; Worth 1995). Through these missions, the Spanish wrought dramatic changes in native labor, settlement behaviors, and diet, reorganizing native populations into aggregated, sedentary, agricultural communities. From the early coastal mission of Santa Catalina de Guale, for instance, plant remains recovered from the mission complex and the nearby village include Old World domesticates such as wheat (*Triticum* sp.), peach (*Prunus persica*), and pea (*Pisum sativum*); New World domesticates such as maize, squash (*Cucurbita* sp.), and bean; nuts such as hickory and acorn; fruits such as maypop, blackberry (*Rubus* sp.), and grape (*Vitis* sp.); and commensals such as chenopod (*Chenopodium* sp.), panicoid grass (*Panicum* sp./*Setaria* sp.), and arrowhead (*Sagittaria* sp.) (Ruhl 1990, 1993). Animal remains recovered from the mission and the village indicate the most extensively used fauna were deer, followed by gar, sea catfishes, and drums (Reitz 1990, 1993). Plant remains from the later Florida panhandle mission of San Luis de Talimali indicate a continuity with the basic aboriginal pattern of reliance on wild plants with some indication of a shift toward cultivated species such as maize and beans. Common plant remains from the site include cultigens of maize and beans, and wild plants such as maypop, persimmon, acorn, and hickory nuts (Newsom and Quitmyer 1992). Animal remains indicate a focus on terrestrial fauna and freshwater fish. Common animal remains recovered from the site include deer, sunfishes (Centrarchidae), freshwater catfish, and turtles (Testudines) (Newsom and Quitmyer 1992).

The data from archaeologically recovered flora and fauna and previous isotopic studies indicate that populations inhabiting this highly diverse region should exhibit diverse patterns in dietary focus and variation in the adoption of agricultural products. We incorporate new stable isotope data from northern Florida in order to synthesize the available information regarding regional dietary stability and variation.

Methods and Materials

Information on the diet of humans can be obtained by comparing isotopic values derived from human bones with isotopic values derived from the tissues of plants and animals that they have consumed (Ambrose and Norr 1993; Schoeninger 1989, 1995; Schoeninger and Moore 1992). Many foods have distinct ratios of the stable isotopes of carbon ($^{13}C/^{12}C$) and nitrogen ($^{15}N/^{14}N$). When eaten, the isotopic composition of the diet is incorporated into body tissues such as bone collagen (DeNiro and Epstein 1978, 1981). In cases where collagen is preserved in adequate quantities, the biogenic isotope signal is retained (Ambrose 1990; DeNiro 1985; Schoeninger and DeNiro 1981). Isotope ratios are expressed using the delta symbol (δ) as parts per thousand (‰) difference from a reference standard, Pee Dee Belemnite (PDB) for carbon and atmospheric nitrogen (AIR) for nitrogen. The δ values for carbon are generally negative, and those for nitrogen are usually positive. The values are calculated using the following equations:

$$\delta^{13}C = \frac{(^{13}C/^{12}C)_{\text{sample}} - (^{13}C/^{12}C)_{\text{PDB}}}{(^{13}C/^{12}C)_{\text{PDB}}} \times 1000\text{‰}$$

$$\delta^{15}N = \frac{(^{15}N/^{14}N)_{\text{sample}} - (^{15}N/^{14}N)_{\text{AIR}}}{(^{15}N/^{14}N)_{\text{AIR}}} \times 1000\text{‰}$$

Carbon isotopic variation is used to differentiate C_3, C_4, and CAM (Crassulacean Acid Metabolism) photosynthetic pathway plant foods, animals feeding on those plants, and animals in terrestrial vs. marine ecosystems (Bender 1968; DeNiro and Epstein 1978; Schoeninger and DeNiro 1984; Smith and Epstein 1971; Tieszen 1991). C_3 plants have $\delta^{13}C$ values averaging near -26‰ and include most temperate grasses, trees, fruits, and tubers. C_4 plants have less negative $\delta^{13}C$ values averaging near -12‰ and include monocot tropical grasses native to the New World such as corn, and dicot plants such as chenopods, setarias, and some amaranths. CAM plants have $\delta^{13}C$ values that occur across the entire range of C_3 and C_4 plants and include succulents, cacti, and bromeliads (O'Leary 1988). Nitrogen isotopic variation distinguishes between most terrestrial and marine organisms (Schoeninger and DeNiro 1984; Schoeninger et al. 1983). Animals generally exhibit a trophic effect with higher $\delta^{15}N$ values for carnivores than herbivores (Schoeninger and DeNiro 1984; Wada 1980). In most cases where legumes use atmospheric nitrogen they show values less than nonlegumes (Shearer and Kohl 1994). Isotopic data from modern plants and animals living in the same climatic zone as the human samples to which they are being compared are often used to establish an interpretive baseline. Because marine organisms have $\delta^{13}C$ isotope values intermediate between C_3 and C_4 plant values, it is not possible to discriminate between various dietary combinations of marine organisms and C_3 and C_4 plants. Consequently, $\delta^{15}N$ isotope values are used in combination with $\delta^{13}C$ isotope values and are illustrated using bivariate plots with $\delta^{13}C$ values plotted on the X axis and $\delta^{15}N$ values plotted on the Y axis (Schoeninger et al. 1990). The general signatures of some of the foods commonly eaten by humans from the circum-Caribbean region are displayed in Figure 1.

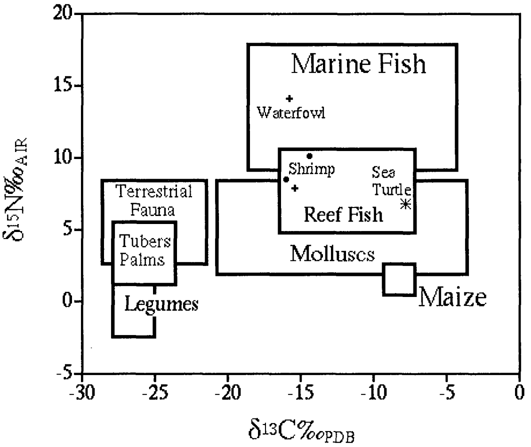

Figure 1. Isotopic composition of preindustrial food resources in the circum-Caribbean region (1.5 percent was added to the $\delta^{13}C$ value of modern foods to compensate for ^{12}C enrichment of the atmosphere from the burning of fossil fuels, as per Tieszen 1991). Figure is based on data from Keegan and DeNiro 1988; Norr 1990; Schoeninger and DeNiro 1984; Schoeninger et al. 1990; Hutchinson and Norr 1997; Norr and Cooke 1998.

For this study, we used methods of isotope analysis that have been previously published (Hutchinson and Norr 1994; Schoeninger et al. 1990). Human bone samples, primarily taken from long bones and ribs, were cleaned of soil and other matrix. The organic portion known as "collagen"

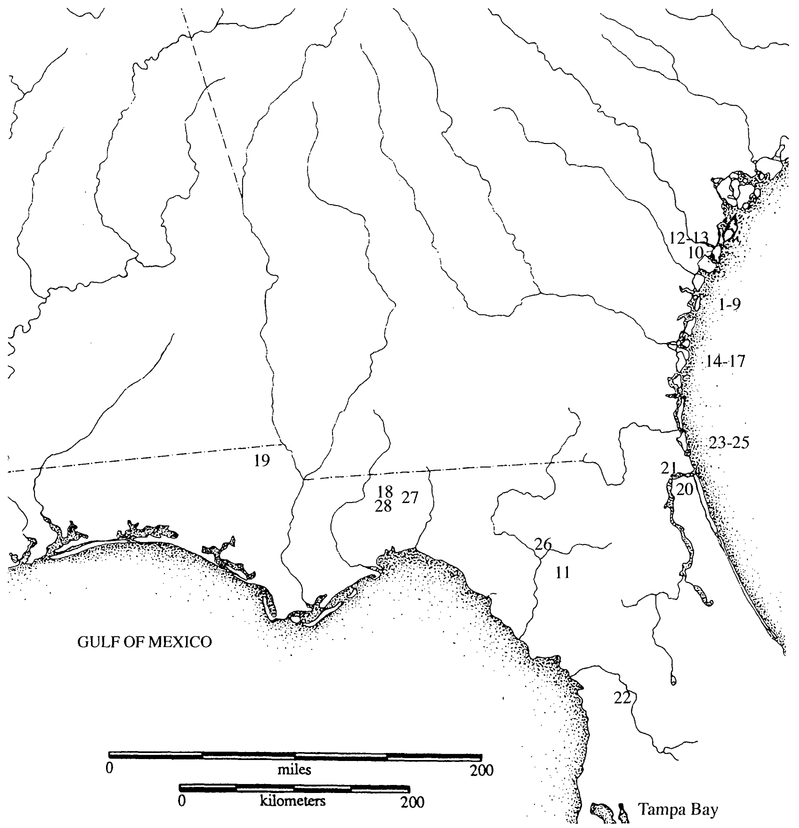

Figure 2. Map showing the sites discussed in this article: 1 = McLeod Mound, 2 = Seaside Mound I, 3 = Seaside Mound II, 4 = Cunningham Mound C, 5 = Cunningham Mound D, 6 = Johns Mound, 7 = Marys Mound, 8 = Southend Mound I, 9 = Santa Catalina de Guale, 10 = Deptford Site, 11 = Henderson Mound, 12 = Irene Burial Mound, 13 = Irene Mortuary, 14 = Martinez B, 15 = Indian Field, 16 = Taylor Mound, 17 = Couper Field, 18 = Lake Jackson, 19 = Waddells Mill Pond, 20 = Browne Mound, 21 = Holy Spirit, 22 = Tatham Mound, 23 = Santa Maria de Yamassee, 24 = Ossuary at Santa Catalina de Santa Maria, 25 = Santa Catalina de Amelia, 26 = San Martin de Timucua, 27 = San Pedro y San Pablo de Patale, 28 = San Luis. Map adapted from Hudson et al. 1989:Figure 1.

was then isolated. All samples except one from St. Catherines Island (MS2876) are adults. All samples were assessed for quality through examination of percent collagen weight yield and carbon to nitrogen ratios (Ambrose and Norr 1992). Modern samples of plants and animals were processed using the same methods as for prehistoric samples with the exception of the collagen extraction stages. Each sample was washed in distilled water and the edible portions were then freeze-dried, ground, and analyzed.

The stable carbon and nitrogen isotope ratio data are derived from human skeletal remains representing 185 individuals from populations living in ecologically and geographically diverse habitation zones spanning a time period from 400 B.C. through A.D. 1700 (Figure 2). The skeletal samples are listed by temporal period and geographic locality in Table 1 and by individual in Table 2. The skeletal samples from early prehistoric Georgia were obtained from five coastal sites: McLeod Mound (9LI47), Seaside Mound I (9LI26), Seaside Mound II (9LI62), Cunningham Mound C (9LI45), and Cunningham Mound D (9LI46). One inland site is represented, Deptford (9CH2), dating between 400 B.C. and A.D. 1000 (DePratter 1979; Larsen 1982; Thomas and Larsen 1979). The early prehistoric Florida data are drawn from one inland skeletal series, Henderson Mound (8A463), an Alachua-tradition site dating to the Hickory Pond period between A.D. 600 and 1250 (Loucks 1976; Milanich 1994).

The nine late prehistoric skeletal series from Georgia are drawn from eight sites dated to the St.

Table 1. Human Isotope Samples by Geographic Location and Time Period.

Site	Location	N	References
Georgia Early Prehistoric: 400 B.C.–A.D. 1000			
McLeod Mound	coastal Georgia	4	Thomas and Larsen 1979; Larsen 1982
Seaside Mound I	coastal Georgia	1	Thomas and Larsen 1979; Larsen 1982
Seaside Mound II	coastal Georgia	3	Thomas and Larsen 1979; Larsen 1982
Cunningham Mound C	coastal Georgia	2	Thomas and Larsen 1979; Larsen 1982
Cunningham Mound D	coastal Georgia	1	Thomas and Larsen 1979; Larsen 1982
Deptford site	inland Georgia	11	Thomas and Larsen 1979; Larsen 1982
Florida Early Prehistoric: A.D. 600–1200			
Henderson Mound	inland Florida	4	Loucks 1976
Georgia Late Prehistoric: A.D. 1000–1450			
Johns Mound	coastal Georgia	10	Larsen and Thomas 1982; Larsen 1982
Marys Mound	coastal Georgia	2	Larsen and Thomas 1982; Larsen 1982
Southend Mound I	coastal Georgia	5	Larsen and Thomas 1986
Irene Burial Mound	inland Georgia	9	Caldwell and McCann 1941; Hulse 1941; Larsen 1982; Anderson 1990
Irene Mortuary	inland Georgia	13	Caldwell and McCann 1941; Hulse 1941; Larsen 1982; Anderson 1990
Martinez B	coastal Georgia	2	Martinez 1975
Indian Field	coastal Georgia	2	Wallace 1975; Zahler 1976
Taylor Mound	coastal Georgia	9	Wallace 1975; Zahler 1976
Couper Field	coastal Georgia	7	Wallace 1975; Zahler 1976
Florida Late Prehistoric and Protohistoric A.D. 1200–1600			
Lake Jackson	inland Florida	4	Jones 1982
Waddells Mill Pond	inland Florida	1	Gardner 1966
Browne Mound	coastal Florida	5	Sears 1959
Holy Spirit	coastal Florida	4	Larsen 1996
Tatham Mound	inland Florida	20	Hutchinson 1991; Hutchinson and Norr 1994; Mitchem 1989
Georgia Early Mission: A.D. 1600–1680			
Santa Catalina de Guale	coastal Georgia	22	Thomas 1987; Larsen 1990; Larsen et al. 1990
Florida Early Mission A.D. 1600–1680			
Santa Maria de Yamassee	coastal Florida	7	Larsen 1993; Saunders 1988
Ossuary at Santa Catalina de Santa Maria	coastal Florida	8	Larsen 1993; Simmons et al. 1989
San Martin de Timucua (Fig Springs)	inland Florida	2	Hann 1990; Hoshower 1992; Hoshower and Milanich 1993; Weisman 1992, 1993
San Pedro y San Pablo de Patale	inland Florida	5	Hann 1990; Jones et al. 1991; Marrinan 1993
Florida Late Mission: A.D. 1680–1700			
San Luis	inland Florida	1	Shapiro and McEwan 1992; McEwan 1993
Santa Catalina de Amelia	coastal Florida	21	Larsen 1993; Saunders 1988

Catherines (A.D. 1000–1150), Savannah (A.D. 1150–1300), and Irene (A.D. 1300–1550) periods (DePratter 1979). Three of these sites are from St. Catherines Island: Johns Mound (9LI18), Marys Mound (9LI20), and Southend Mound I (9LI3) (Larsen 1982; Larsen and Thomas 1982, 1986). Four skeletal series are from St. Simons Island: Martinez B, Indian Field, Taylor Mound (9GN55), and Couper Field (Martinez 1975; Wallace 1975; Zahler 1976). Two temporally and spatially distinct series from the Irene site (9CH1) in Georgia, the Irene Burial Mound and the Irene Mortuary, are included in the analysis. The Irene site is located just north of the city of Savannah on the north Georgia coast about 10 miles up the Savannah River and was occupied from approximately A.D. 1150 to 1450 (Caldwell and McCann 1941; Hulse 1941; Larsen 1982; Powell 1990; Thomas and Larsen 1982).

The late prehistoric data from Florida are drawn

Table 2. Stable Isotope Results by Individual.

Lab No.	Site	Burial	Sex	$\delta^{13}C$	$\delta^{15}N$
UCT389	McLeod Mound	13	F	-17.1	13.1
UCT391	McLeod Mound	15	F	-18.6	12.9
UCT392	McLeod Mound	16	F	-13.8	12.6
UCT393	McLeod Mound	17	F	-13.6	12.4
UCT385	Seaside I	14	M	-15.0	—
UCT386	Seaside II	11	M	-13.8	10.6
UCT387	Seaside II	13	F	-15.7	—
UCT388	Seaside II	14	F	-13.4	13.2
UCT394	Cunningham, Mound C	1	F	-16.0	14.4
UCT395	Cunningham, Mound C	3	F	-14.8	—
UCT396	Cunningham, Mound D	2	M	-13.9	12.9
UCT335	Deptford	4	F	-14.5	11.3
UCT384	Deptford	4	F	-13.4	11.3
UCT382	Deptford	8	F	-18.6	10.7
UCT337	Deptford	13	F	-17.5	9.6
UCT338	Deptford	16	F	-17.7	—
UCT339	Deptford	17	F	-16.7	11.6
UCT340	Deptford	18	M	-15.6	12.9
UCT341	Deptford	22	F	-16.0	11.8
UCT342	Deptford	28	M	-16.8	12.0
UCT343	Deptford	29	M	-17.1	9.6
UCT344	Deptford	40	M	-12.6	10.4
UCT372	Johns Mound	1	M	-14.2	11.6
UCT379	Johns Mound	14	M	-13.4	13.1
UCT377	Johns Mound	16	F	-14.6	13.3
UCT376	Johns Mound	18	F	-13.9	13.6
UCT374	Johns Mound	26	I	-13.7	12.3
UCT370	Johns Mound	36	I	-14.1	13.0
UCT375	Johns Mound	37	F	-14.4	12.7
UCT378	Johns Mound	47	M	-14.3	13.5
UCT373	Johns Mound	—	M	-14.2	12.9
UCT371	Johns Mound	11A	M	-14.2	13.3
UCT380	Marys Mound	1	F	-14.3	11.8
UCT381	Marys Mound	5	F	-14.7	12.9
UCT349	Irene Burial Mound	2	F	-14.0	9.6
UCT350	Irene Burial Mound	3	M	-13.3	10.4
UCT351	Irene Burial Mound	4	M	-10.0	10.6
UCT353	Irene Burial Mound	5	M	-12.4	10.5
UCT352	Irene Burial Mound	7	F	-10.8	9.5
UCT355	Irene Burial Mound	12	F	-16.4	10.1
UCT356	Irene Burial Mound	14	F	-13.9	11.2
UCT357	Irene Burial Mound	16	M	-14.4	10.8
UCT358	Irene Burial Mound	72	F	-11.5	13.3
UCT359	Irene Mortuary	8	M	-17.4	10.7
UCT359	Irene Mortuary	8	M	-17.4	10.7
UCT354	Irene Mortuary	9	F	-16.4	—
UCT360	Irene Mortuary	64	M	-16.8	9.2
UCT361	Irene Mortuary	69	M	-17.9	8.7
UCT362	Irene Mortuary	70	M	-17.0	10.4
UCT363	Irene Mortuary	74	F	-14.5	9.7
UCT364	Irene Mortuary	75	M	-13.7	10.2
UCT365	Irene Mortuary	107	M	-17.7	9.9
UCT366	Irene Mortuary	108	F	-17.0	9.6
UCT367	Irene Mortuary	109	M	-17.9	10.2
UCT368	Irene Mortuary	110	F	-15.6	10.0
UCT369	Irene Mortuary	111	F	-17.2	9.6

Table 2. Continued.

Lab No.	Site	Burial	Sex	$\delta^{13}C$	$\delta^{15}N$
MS4843	Southend Md I	5	M	-13.3	13.1
MS4844	Southend Md I	6	F	—	12.5
MS4847	Southend Md I	16	F	—	10.4
MS4850	Southend Md I	24	F	13.2	12.8
MS4851	Southend Md I	27	F	-12.4	11.7
$386	Couper Field	2	F	-13.8	12.8
$382	Couper Field	5	M	-14.0	12.8
$387	Couper Field	7	F	-14.2	12.1
$383	Couper Field	8	M	-12.4	11.8
$384	Couper Field	11	M	-13.9	11.4
$388	Couper Field	13	F	-14.5	11.7
$385	Couper Field	15	M	-13.6	13.5
$371	Indian Field	4	M	-14.8	14.8
$372	Indian Field	5	F	-14.8	13.2
$369	Martinez B	2	M	-13.4	14.1
$370	Martinez B	3	M	-12.7	13.6
$376	Taylor Mound	2	F	-13.0	12.7
$373	Taylor Mound	3	M	-12.5	13.6
$377	Taylor Mound	4	F	-13.7	12.1
$378	Taylor Mound	5	F	-13.9	12.7
$374	Taylor Mound	6	M	-9.9	12.2
$375	Taylor Mound	8	M	-10.2	12.8
$379	Taylor Mound	9	F	-13.3	11.5
$380	Taylor Mound	11	F	-11.1	11.0
$381	Taylor Mound	379	F	-11.1	12.5
MS4610	Browne Mound	7	F	-12.4	14.0
MS4604	Browne Mound	11	F	-17.1	13.2
MS4608	Browne Mound	18	M	-12.3	14.2
MS4603	Browne Mound	19	M	-17.4	9.2
MS4607	Browne Mound	46	M	-13.4	13.2
MS4617	Holy Spirit	7	F	-17.3	12.2
MS4619	Holy Spirit	8	M	-18.1	—
MS4620	Holy Spirit	9	M	-19.4	12.8
MS4622	Holy Spirit	11	F	-17.1	11.8
MS4615	Henderson Mound	14	I	-17.9	9.0
MS4613	Henderson Mound	27	I	-16.1	11.2
MS4612	Henderson Mound	32	I	-13.2	9.1
MS4614	Henderson Mound	34	I	-16.3	11.9
DH39	Waddell's Mill Pond	65	I	-12.8	10.4
MS4599	Lake Jackson	6	M	-14.6	9.1
MS4600	Lake Jackson	7	F	-13.7	13.0
MS4601	Lake Jackson	10	F	-14.0	8.8
MS4602	Lake Jackson	16	F	-13.6	9.3
DH10	Tatham Mound	113	F	-17.5	10.9
DH7	Tatham Mound	127	M	-20.3	11.9
DH23	Tatham Mound	1	F	-18.8	11.8
DH48	Tatham Mound	2	F	-13.8	10.1
DH24	Tatham Mound	9	M	-18.7	12.0
DH8	Tatham Mound	14	F	-15.6	10.9
DH4	Tatham Mound	16	M	-13.9	11.4
DH11	Tatham Mound	17	M	-15.8	11.5
DH13	Tatham Mound	24	I	-18.4	12.0
DH9	Tatham Mound	30	M	-17.7	11.7
DH16	Tatham Mound	33	I	-16.9	10.8
DH1	Tatham Mound	42	I	-18.1	12.0
DH17	Tatham Mound	48	I	-18.6	12.0

Table 2. Continued.

Lab No.	Site	Burial	Sex	$\delta^{13}C$	$\delta^{15}N$
DH14	Tatham Mound	51	M	-18.5	12.6
DH15	Tatham Mound	55	I	-19.1	11.9
DH6	Tatham Mound	56	I	-19.7	11.7
DH30	Tatham Mound	66	F	-17.8	10.3
DH42	Tatham Mound	77	F	-15.0	10.4
DH29	Tatham Mound	86	F	-17.3	11.7
DH12	Tatham Mound	120	I	-18.6	11.6
MS2835	Santa Catalina de Guale	9	F	- 9.6	7.4
MS2836	Santa Catalina de Guale	18	M	-11.7	9.6
MS2838	Santa Catalina de Guale	22	F	-12.4	9.6
MS2839	Santa Catalina de Guale	39	M	-11.6	10.4
MS2840	Santa Catalina de Guale	41	M	-11.0	9.8
MS2841	Santa Catalina de Guale	46	M	-10.4	8.5
MS2844	Santa Catalina de Guale	58	F	-12.0	9.5
MS2832	Santa Catalina de Guale	60	F	-14.3	9.5
MS2848	Santa Catalina de Guale	64	F	-11.8	9.9
MS2849	Santa Catalina de Guale	74	M	- 9.7	7.5
MS2850	Santa Catalina de Guale	88	F	-11.0	9.7
MS2851	Santa Catalina de Guale	98	F	-11.2	8.9
MS2857	Santa Catalina de Guale	99	F	-12.1	9.0
MS2861	Santa Catalina de Guale	107	M	-10.8	10.8
MS2865	Santa Catalina de Guale	123	F	-11.2	10.2
MS2862	Santa Catalina de Guale	160	I	-12.9	9.9
MS2869	Santa Catalina de Guale	169	M	-11.6	9.3
MS2871	Santa Catalina de Guale	219	I	-11.0	8.9
MS2876	Santa Catalina de Guale	235	I	-10.6	10.0
MS2879	Santa Catalina de Guale	276	F	-11.3	9.4
MS2877	Santa Catalina de Guale	294	M	-11.4	9.8
MS2859	Santa Catalina de Guale	isolated	I	-12.6	9.6
MS3280	Ossuary at Amelia Island	1	M	-12.1	9.8
MS3281	Ossuary at Amelia Island	2	M	-12.1	10.6
MS3282	Ossuary at Amelia Island	3	M	-11.5	10.0
MS3283	Ossuary at Amelia Island	4	M	-13.4	10.1
MS3284	Ossuary at Amelia Island	5	F	-12.8	10.2
MS3285	Ossuary at Amelia Island	6	F	-11.3	10.8
MS3286	Ossuary at Amelia Island	7	F	-12.4	9.4
MS3287	Ossuary at Amelia Island	8	F	-12.0	10.8
MS4575	Santa Maria de Yamasee	15	M	-12.0	14.5

Table 2. Continued.

Lab No.	Site	Burial	Sex	$\delta^{13}C$	$\delta^{15}N$
MS4585	Santa Maria de Yamasee	16	F	-12.0	12.2
MS4586	Santa Maria de Yamasee	42	F	-11.6	11.9
MS4587	Santa Maria de Yamasee	51	M	-12.8	11.2
MS4588	Santa Maria de Yamasee	67	F	-12.0	9.5
MS4589	Santa Maria de Yamasee	74	M	-13.6	7.3
MS4590	Santa Maria de Yamasee	83	F	-12.5	9.5
MS4591	Fig Springs	91	M	-12.7	7.9
MS4595	Fig Springs	92	M	-12.1	9.4
MS4581	Patale	14	M	-12.2	9.0
MS4582	Patale	34	F	-14.2	5.8
MS4578	Patale	41	F	-10.2	8.7
MS4577	Patale	46	M	-10.0	9.6
MS4584	Patale	61	F	-11.0	6.4
MS4611	San Luis	3	M	-16.5	12.3
MS3248	Santa Catalina de Amelia	1	F	-11.1	10.9
MS3249	Santa Catalina de Amelia	6	M	-10.2	11.0
MS3250	Santa Catalina de Amelia	7	F	-11.3	10.1
MS2832	Santa Catalina de Amelia	11	M	-12.4	9.8
MS3251	Santa Catalina de Amelia	15	M	-11.3	10.1
MS2834	Santa Catalina de Amelia	19	F	-12.1	8.8
MS3252	Santa Catalina de Amelia	20	F	-11.8	10.5
MS3254	Santa Catalina de Amelia	30	F	-11.1	9.6
MS3255	Santa Catalina de Amelia	34	M	-10.9	9.8
MS3256	Santa Catalina de Amelia	36	F	-11.3	9.4
MS3257	Santa Catalina de Amelia	45	M	-10.0	8.6
MS3258	Santa Catalina de Amelia	50	F	-12.2	10.3
MS3271	Santa Catalina de Amelia	59	M	-11.4	10.3
MS3272	Santa Catalina de Amelia	60	F	-12.2	9.6
MS3273	Santa Catalina de Amelia	65	M	-10.4	10.2
MS3274	Santa Catalina de Amelia	66	F	-12.5	8.3
MS3275	Santa Catalina de Amelia	73	M	-10.5	8.8
MS3276	Santa Catalina de Amelia	78	M	-12.5	11.6
MS3277	Santa Catalina de Amelia	88	F	-12.6	10.1
MS3278	Santa Catalina de Amelia	91	F	-12.1	9.7
MS3279	Santa Catalina de Amelia	95	M	-12.5	10.9

I = indeterminate

from five skeletal series. The two northern inland skeletal series, Lake Jackson (8LE1) and Waddells Mill Pond (8JA65), are dated between A.D. 1100 and 1400 (Gardner 1966; Jones 1982). These Precolumbian people inhabited the northwestern corner of the Florida panhandle, the historic tribal area of the Apalachee, and the area of the Fort Walton culture (A.D. 1000–1550) (Hann 1988; Milanich 1994; Scarry 1990a). Lake Jackson, the largest site in the region, was a multiple mound and village complex in Leon County (Milanich 1994:369). A little farther northwest in Jackson County is Waddells Mill Pond, a smaller, palisaded Fort Walton site (Gardner 1966). The mounds, plaza, and copper objects found at Lake Jackson confirm the connection of Fort Walton to the Mississippian culture sphere and the presence of chiefdoms in northern Florida.

Complementing these late prehistoric inland Florida data are data from two coastal Florida skeletal series located at or near the mouth of the St. Johns River and dating between A.D. 750 and 1550, the St. Johns II period. The Holy Spirit Church site, also called the McCormick site (8DU66), remains were found in a cemetery context and may be protohistoric in date, although the ceramic sequence at the site spans the St. Johns period from 500 B.C. through contact (Larsen 1996). Browne Mound (8DU62) produced 44 primary and secondary burials (Milanich 1994; Sears 1959).

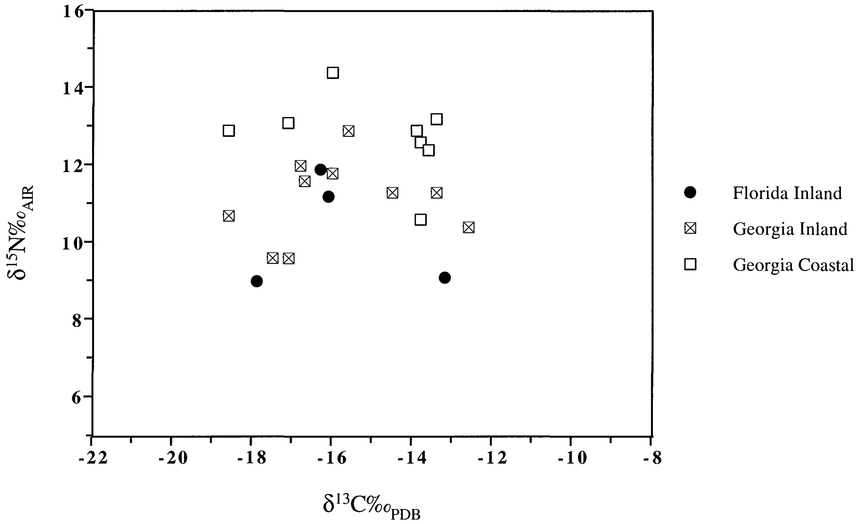

Figure 3. Isotopic signatures from early prehistoric Georgia and Florida populations. In this and all other plots filled and solid symbols indicate inland populations and open symbols indicate coastal populations.

Tatham Mound (8CI203), located in central Gulf Coast Florida, is comprised of two components: a prehistoric component dated between A.D. 1200 and 1450 (Pinellas phase of Safety Harbor; Mitchem 1989) and a protohistoric component dated between A.D. 1525 and 1550 (Tatham phase of Safety Harbor; Mitchem 1989). Although visited by at least one Spanish *entrada,* the effects of European contact with regard to diet were likely minimal given the short duration of interaction and the apparent rapid disappearance of populations from the region (Hutchinson 1991; Hutchinson and Norr 1994; Mitchem 1989). For this reason, it is included with the late prehistoric series. The site is located within the rich lacustrine and riverine environment of the Withlacoochee River and Lake Tsala Apopka.

The earliest mission-period sample comes from the early mission site on St. Catherines Island, Georgia—Santa Catalina de Guale (9LI274)—dated between A.D. 1600 and 1680 (Larsen 1990; Larsen et al. 1990, 1998; Thomas 1987). Two early mission Florida skeletal samples are from coastal localities on Amelia Island, Florida: Santa Maria de Yamasee (8NA41) and the protohistoric ossuary at Santa Catalina de Santa Maria (8NA41). Two samples are from inland localities, the San Martín de Timucua (Fig Springs; 8CO1) and San Pedro y San Pablo de Patale (8LE152) sites. All four early mission sites from Florida date to the seventeenth century. Two late mission-period Florida skeletal series date to the late seventeenth and early eighteenth century: the inland San Luis de Talimali (8LE4) in present-day Tallahassee and Santa Catalina de Santa Maria (8NA41) on Amelia Island.

Results

Early Prehistoric (400 B.C.–A.D. 1000)

The difference between terrestrial and coastal foraging patterns is well illustrated by comparing the mean isotope values of the Deptford site ($\delta^{13}C$ = -16.0; $\delta^{15}N$ = 11.1) with those from the coastal populations (McLeod Mound, Seaside I and II, Cunningham Mounds C and D—$\delta^{13}C$ = -15.1; $\delta^{15}N$ = 12.8; Table 3). Local ecological circumstances

Table 3. Summary of Stable Isotope Results for Early Prehistoric Georgia and Florida Populations by Total Sample and by Sex.

	N	$\delta^{13}C$	S.D.	$\delta^{15}N$	S.D.
Coastal Georgia					
Females	8	-15.4	1.8	13.1	.7
Males	3	-14.2	.7	11.8	1.6
All	11	-15.1	1.7	12.8	1.1
Inland Georgia					
Females	7	-16.3	1.9	11.1	.8
Males	4	-15.5	2.1	11.2	1.5
All	11	-16.0	1.9	11.1	1.1
Inland Florida					
All	4	-15.9	2.0	10.3	1.5

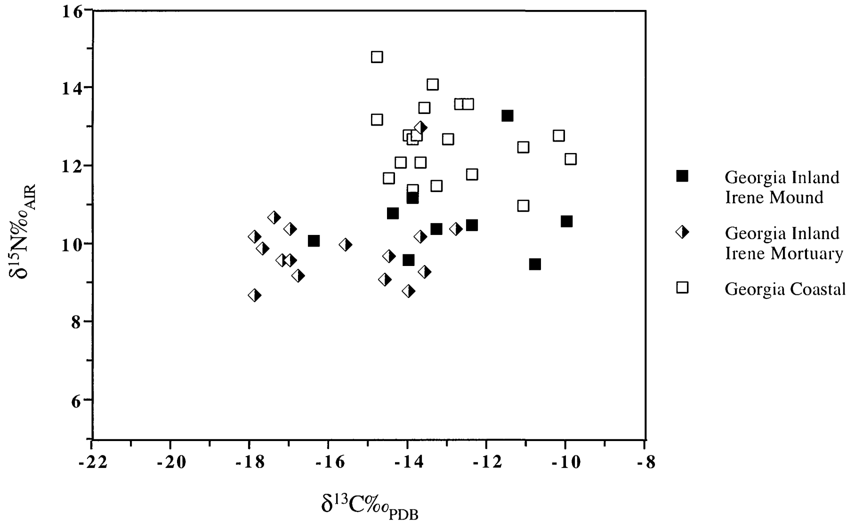

Figure 4. Isotopic signatures from late prehistoric Georgia populations.

undoubtedly influenced dietary selection during this early 1,500-year time span, and the more negative carbon and less positive nitrogen isotope values in the Deptford series reflect the dietary inclusion of more terrestrial resources as compared to the coastal groups (Table 3; Figure 3). However, the least negative $\delta^{13}C$ values (such as values ranging from -13.0 to -14.5) require some explanation. A pure C_3 plant $\delta^{13}C$ signature would be approximately -21.0. This suggests some consumption of C_3- or C_4-like plants. One possibility raised by Little and Schoeninger (1995) for similar $\delta^{13}C$ values from Nantucket is the incorporation of nearshore intertidal and subtidal plants into the food chain. A second possible explanation is the consumption of shellfish or other marine protein sources. Those resources have $\delta^{13}C$ signatures compatible with those from the mean isotope values for the early prehistoric coastal populations. There are no significant sex differences for the isotopic values.

The mean isotopic signatures ($\delta^{13}C = -15.9$; $\delta^{15}N = 10.3$) from the inland Florida Henderson Mound (A.D. 600–1200) indicate little consumption of maize and a mixed dietary regime with an emphasis on terrestrial animal resources combined with C_3 plants (Table 3; Figure 3). There are no significant sex differences for the isotopic values.

Late Prehistoric and Protohistoric (A.D. 1000–1600)

The period between A.D. 1000 and 1450 marks the beginning of a general trend in Georgia toward less negative $\delta^{13}C$ values for coastal and inland populations with some reduction in $\delta^{15}N$ for the inland populations. Mean isotope values for inland individuals from the Irene site show a slightly less negative $\delta^{13}C$ value ($\delta^{13}C = -15.1$) compared with the previous period ($\delta^{13}C = -16.0$) with a decreased $\delta^{15}N$ value ($\delta^{15}N = 10.2$) as compared to the previous period ($\delta^{15}N = 11.1$). There is also a shift in mean isotope values for the coastal populations from St. Simons Island (Martinez B, Indian Field, Taylor Mound, Couper Field) and St. Catherines Island (Johns Mound, Marys Mound, Southend Mound I). The coastal $\delta^{13}C$ value ($\delta^{13}C = -13.4$) is much less negative than the previous period coastal value ($\delta^{13}C = -15.1$) with a similar $\delta^{15}N$ value ($\delta^{15}N = 12.6$) as the preceding period ($\delta^{15}N$

Table 4. Summary of Stable Isotope Results for Late Prehistoric Georgia Populations by Total Sample and Sex.

	N	$\delta^{13}C$	S.D.	$\delta^{15}N$	S.D.
Coastal Georgia					
Females	19	-13.6	1.1	12.3[a]	.8
Males	16	-13.2	1.4	13.0[a]	.9
All	37[b]	-13.4	1.2	12.6	.9
Inland Georgia					
Females	10	-14.7	2.2	10.3	1.2
Males	12	-15.5	2.6	10.2	.6
All	22	-15.1	2.4	10.2	.9

[a] Significant differences in t-test at $p \leq .05$ level.
[b] Sex determinations were not possible for all individuals.

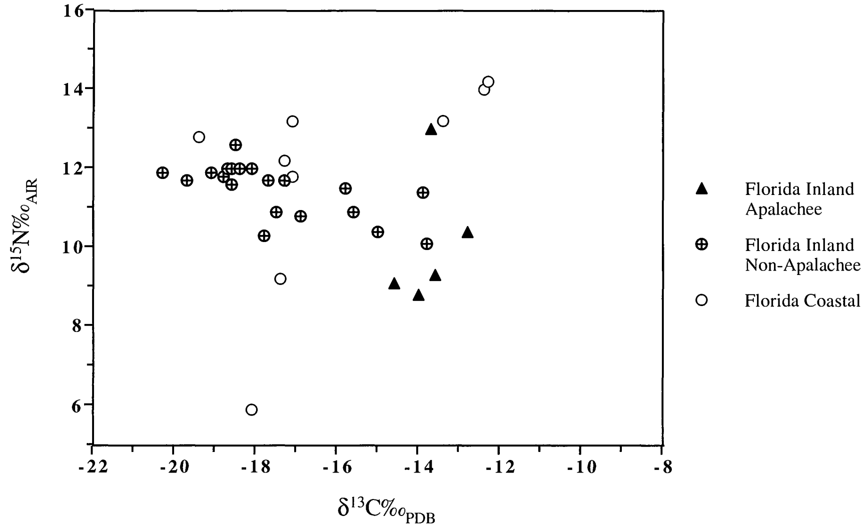

Figure 5. Isotopic signatures from late prehistoric Florida populations.

= 12.8). These changes suggest that the coastal populations increased C_4 plant consumption, presumably maize and continued reliance on marine resources as indicated by the less negative $\delta^{13}C$ values and relatively similar $\delta^{15}N$ isotope values (Figure 4). In contrast, the inland Irene site population appears to have consumed far more terrestrial food resources and less marine resources indicating a strong preference for highly localized subsistence resources. Summary data for the total sample and by sex are presented in Table 4. There are significant differences between Georgia coastal males and females for the $\delta^{15}N$ values (t-test, $p \leq .05$; males = 13.0; females = 12.3).

At the Lake Jackson and Waddells Mill Pond sites in Florida, the mean isotope values show a dramatic increase in $\delta^{13}C$ values (-13.7) from the earlier inland Henderson Mound (-15.9), while the $\delta^{15}N$ values (10.1) remain unchanged from the earlier values at Henderson (10.3). Mean isotope values ($\delta^{13}C$ = -16.1; $\delta^{15}N$ = 12.6) for individuals interred at two late prehistoric Atlantic coastal mortuary sites, Holy Spirit and Browne Mound, indicate the use of marine resources and little consumption of maize. Individuals from the inland central Florida late prehistoric and protohistoric Tatham Mound have very negative mean $\delta^{13}C$ isotope values (-17.5) indicating little consumption of maize. The $\delta^{15}N$ isotope values (11.5) lie between the coastal and terrestrial values for the other Florida localities. Elsewhere, we have attributed these isotope values to the dietary use of the abundant lacustrine and riverine resources available from the adjacent Lake Tsala Apopka and Withlacoochee River watersheds (Hutchinson and Norr 1994). When considered together, the Florida data suggest that during the late prehistoric period maize was little used except for the Lake Jackson Mississippian center in northern Florida. In fact, these data suggest that before contact there was little maize in the diet of Florida populations inhabiting regions elsewhere (Figure 5). Examination of the Florida data by sex for each of the sample classes (Table 5) showed significant differences (t-

Table 5. Summary of Stable Isotope Results for Late Prehistoric Florida Populations by Total Sample and Sex.

	N	$\delta^{13}C$	S.D.	$\delta^{15}N$	S.D.
Northern Coastal Florida					
Females	4	-16.0	2.4	12.8	1.0
Males	5	-16.1	3.1	12.4	2.2
All	9	-16.1	2.6	12.6	1.6
Northern Inland Florida					
Females	3	-13.8	.2	10.4	2.3
Males	1[a]	-14.6	—	9.1	—
All	5[b]	-13.7	.7	10.1	1.7
Central Inland Florida					
Females	7	-16.5	1.8	10.9[c]	.7
Males	6	-17.5	2.3	11.9[c]	.4
All	20[b]	-17.5	1.8	11.5	.7

[a] Small sample size.
[b] Sex determinations were not possible for all individuals.
[c] Significant difference in t-test at $p \leq 0.01$ level.

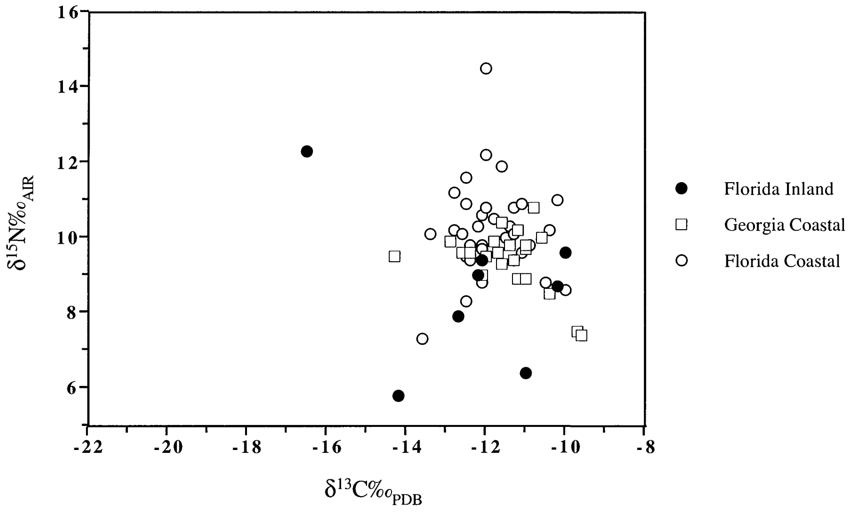

Figure 6. Isotopic signatures from mission-period Georgia and Florida populations.

test; $p \leq .01$) in the diet of the inland northern Florida individuals as indicated by the $\delta^{15}N$ values (males = 11.9; females = 10.9).

Mission Period (A.D. 1600–1700)

In the seventeenth century, the period of missionization of native populations, the $\delta^{13}C$ and $\delta^{15}N$ stable isotope values change dramatically for both coastal and inland populations relative to precontact groups. The mean isotope values for the Georgia coastal mission (Santa Catalina de Guale on St. Catherines Island: $\delta^{13}C = -11.5$; $\delta^{15}N = 9.4$), the coastal missions in Florida (Santa Maria de Yamassee, Santa Catalina de Santa Maria, Santa Catalina de Amelia: $\delta^{13}C = -11.8$; $\delta^{15}N = 10.2$), and the inland Florida missions (San Martin de Timucua, San Pedro y San Pablo de Patale, and San Luis: $\delta^{13}C = -12.4$; $\delta^{15}N = 8.6$) all have less negative $\delta^{13}C$ values and less positive $\delta^{15}N$ values as compared to earlier populations from the same region. These findings indicate native populations were increasingly relying on a C_4 plant, undoubtedly maize, while reducing their emphasis on marine resources (Figure 6; Table 6). The isotopic evidence, indicating an increase in maize production and consumption as part of the Spanish colonial effort, is consistent with all ethnohistoric, biological, and archaeological evidence (Bushnell 1994; Hann 1988, 1996; Hudson 1997; Larsen 1990, 1993; Larsen et al. 1990; Newsom 1987, 1991; Newsom and Quitmyer 1992; Reitz and Scarry 1990; Ruhl 1990, 1993; Scarry 1993c). There were no significant differences during this period in the isotopic values between males and females.

Table 6. Summary of Stable Isotope Results for Mission-Period Georgia and Florida Populations by Total Sample and Sex

	N	$\delta^{13}C$	S.D.	$\delta^{15}N$	S.D.
Coastal Florida					
Females	19	-11.9	.5	10.1	1.0
Males	17	-11.7	1.1	10.3	1.5
All	36	-11.8	.8	10.2	1.2
Coastal Georgia					
Females	10	-11.7	1.2	9.3	.8
Males	8	-11.0	.7	9.5	1.1
All	22[a]	-11.5	1.0	9.4	.8
Inland Florida					
Females	3	-11.8	2.1	7.0	1.5
Males	5	-12.7	2.4	9.6	1.6
All	8	-12.4	2.2	8.6	2.0

[a] Sex determinations were not possible for all individuals.

Discussion and Conclusions

Our data indicate clear regional specializations that reflect in large part local ecology, especially before the arrival of Europeans. In particular, consumption of local resources contributed to the isotope patterns that serve to differentiate coastal from inland populations. When Florida and Georgia populations are compared, it is clear that marine resources were an important part of the diet on the Georgia coast (Figure 7). The stable isotope data from Georgia indicate that foraging gave way

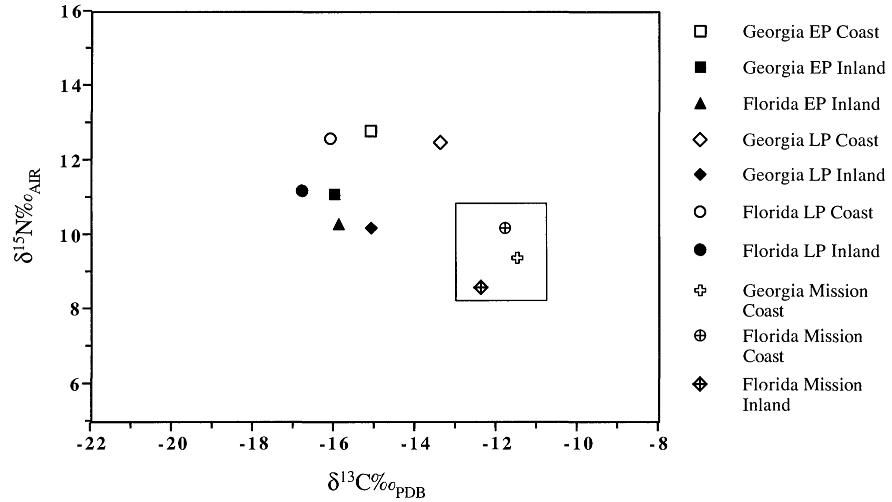

Figure 7. Mean isotopic signatures from the total sample of Georgia and Florida populations. Box indicates mission-period populations.

to horticulture after A.D. 1000. In general, there was a steady increase in maize reliance through time that continued into the contact period. Dental microwear data lend further support to the idea that a gradual dietary shift occurred in coastal Georgia; a trend from more pitting and greater scratch width in the early prehistoric samples to one of less pitting and decreased scratch width in the contact samples indicates a trend from consuming harder objects and larger abrasives to one of consuming less hard objects and smaller abrasives (Teaford 1991). It is also clear, however, that local dietary variation continued until the arrival of the Spaniards. Late prehistoric island dwellers have significantly different nitrogen signatures from mainland dwellers. At the Irene site, 10 miles up the Savannah River, isotope results indicate reliance on more terrestrial resources and less reliance on the suite of marine resources indicated for coastal populations. These data are interesting given the abundant marine and freshwater shell used in mound construction (Anderson 1994; Caldwell and McCann 1941). Furthermore, there appears to be a decrease in maize consumption at Irene between the Savannah and Irene components that may be associated with the collapse of the Savannah-period chiefdom (Anderson 1994; Larsen, Schoeninger, van der Merwe, Moore, and Lee-Thorpe 1992).

The prehistoric and protohistoric Florida dietary signatures, with the exception of the Mississippian-influenced Lake Jackson and Waddells Mill Pond sites, show little evidence of maize consumption before the mission period. Maize is certainly more important at Lake Jackson than at Tatham Mound in central Florida during both the precontact (A.D. 1200–1450) and early contact periods (A.D. 1525–1550). This pattern of maize use is consistent with the ethnohistoric accounts of the Spanish exploratory expeditions of Narváez and DeSoto that report limited availability and use of maize in central Florida between A.D. 1525 and 1550 (Bourne 1922; Hudson 1997; Oviedo 1944; Smith 1968 [1866]). According to a Spanish account, Ranjel, a member of DeSoto's *entrada*, having traveled several days north of the bay, reported that:

> they came to the plain of Guaçoco, and the soldiers went into the corn fields and gathered the green corn with which they cheered themselves a little, for it was the first they had seen in that country [Bourne 1922:64].

Accounts of the expedition (Oviedo 1944; Smith 1968) contain similar reports of sporadic maize fields until the expedition reached the Apalachee province to the north. Archaeological data support this interpretation. Newsom (1991) reported that 16 systematic archaeobotanical studies in peninsular Florida have yielded maize only in postcontact deposits. Maize has been recovered from Hontoon Island, for instance, but within middle to late seventeenth-century deposits exclusively (Newsom 1987). Apalachee province, on the other hand, had a well-established agricultural economy at the time of the Spanish arrival (Hann 1988). Ethnohistoric documents generally describe the Timucua of northern Florida as relatively sedentary maize horticulturalists (Hann 1988, 1996). In fact, a major impetus for the development of the mission chain, according to Hann (1988:132), was the need for further agricultural support of the colonial centers. Archaeologists have recovered maize from Fort Walton–period sites dating between A.D. 1000 and 1500 (Scarry 1993c). Ceramics with corncob impressions from Apalachee sites suggest that after A.D. 600 maize was relatively important, but data from Henderson Mound indicate that it was not a major dietary constituent at this time.

There is a general convergence of diet in the mission period. The data show a shift from an early prehistoric heterogeneous diet with distinctions occurring between Florida and Georgia, and coastal and noncoastal to a largely homogeneous diet in the mission period. Information available from the study of plant remains (Newsom 1987; Newsom and Quitmyer 1992; Reitz and Scarry 1985, 1990; Ruhl 1990, 1993; Scarry 1993c) suggests that the Spanish focused heavily on the indigenous triad of maize, beans, and squash. Old World plants, perhaps because they would not grow well in the Southeast, were utilized only occasionally. A similar pattern is indicated for use of Old World domesticated animals, although more variation seems apparent with animal use at the various regionally distinctive missions remaining somewhat heterogeneous (Reitz 1993:390). For instance, fish contributed little (23 percent) to the total faunal assemblage for Santa Catalina de Guale on St. Catherines Island; however, recovery bias may contribute to the relatively low number of fish (Reitz 1993:388–389). On the other hand, at the contemporary Fountain of Youth site near St. Augustine, marine vertebrates contributed 90 percent of the total faunal sample (Reitz 1993:387). Although there are still some distinctions between the coastal mission sites and those located inland in our study, the isotope data indicate a general trend toward increased maize consumption and decreased consumption of marine foods. Interestingly, however, there is clear indication from the sixteenth- and seventeenth-century St. Augustine faunal assemblages that most of the animals consumed were sharks and bony fishes, especially those from estuarine contexts (Reitz 1992, 1993).

These results suggest that the overall process of agricultural transition in Georgia and Florida was not homogeneous in either geographic or chronological location. The adoption of maize appears to have occurred later in most Florida populations than in Georgia coastal populations. With the advent of European colonization and missionization, the Spaniards introduced more homogeneity in subsistence patterns, resulting in increased emphasis on horticulture and decreased emphasis on foraging.

These dietary changes have profound implications for the health and behavior of native populations in the wider region of Spanish Florida. Increased focus on maize after contact had certain negative consequences on the health of native populations. Maize is deficient in the essential amino acids lysine and tryptophan, and the presence of phytate results in decreased bioavailability of iron. Thus, the shift in dietary focus following the arrival of Europeans and establishment of European missions provides an important context for understanding the decline in health so well documented in this region (e.g., Larsen, Ruff, Schoeninger, and Hutchinson 1992). It comes as little surprise, therefore, that the cranial pathological conditions associated with iron deficiency anemia—porotic hyperostosis and cribra orbitalia—are significantly more prevalent in the mission period relative to the late prehistoric period (see Larsen, Ruff, Schoeninger, and Hutchinson 1992). Walker (1986) and Walker et al. (1989) have previously suggested that an additional explanation for increased prevalence of anemia is contamination of water supplies in nucleated mission settlements. Coincident with increased maize consumption is a moderate increase in carious lesion prevalence in the precontact Georgia agriculturalists and a dramatic increase in the late contact Florida and Georgia mission series (Larsen et al. 1991, 1998).

Analysis of dental enamel defects known as enamel hypoplasias provides further documentation that postcontact native Florida and Georgia populations experienced increased physiological stress as compared to precontact populations

(Hutchinson and Larsen 1988, 1990; Larsen 1994; Larsen and Hutchinson 1992; Simpson et al. 1990). Non-specific infections of bone known as periosteal reactions show a striking increase in frequency in contact-period native populations in La Florida, 15.8 percent in precontact males as compared to 52.8 percent for contact males and from 16 percent to 27.7 percent for females (Larsen 1994; Larsen and Harn 1994). Work demands apparently increased for postcontact native populations as documented by increased prevalence of osteoarthritis and biomechanical analysis of the cross sections of diaphyses of femora and humeri (Fresia et al. 1990; Larsen 1994; Larsen and Ruff 1994; Ruff and Larsen 1990).

The data from precontact and postcontact human remains from La Florida, particularly in Georgia, indicate that declines in health began prior to the Europeans and were associated with an increased consumption of maize. Thus, the decline in Georgia and Florida native populations before the eighteenth century must be interpreted in light of not only the introduction of European-introduced Old World infections but also the shift in and changing quality of diet.

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