A PROPOSED METHODOLOGY FOR PREDICTING THE CARBON AND NITROGEN STABLE ISOTOPE MEASURES OF K'INICH YAX K'UK MO', COPAN DYNASTIC FOUNDER

by

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ABSTRACT

The purpose of this thesis is to show that stable isotope analysis can be used to predict K'inich Yax K'uk Mo's stable isotope measures based on Stuart's (2007) hypothesis that K'inich Yax K'uk Mo', the dynastic founder of the Copan royal lineage, was a Caracol lord. There is significant and convincing evidence that K'inich Yak K'uk Mo' had a non-Copanec origin. Stable isotope analysis is a tested and reliable method for detailing diets and migratory paths of ancient humans and this theory is applied as a predictor of the stable isotope measures of K'inich Yax K'uk Mo', if he did in fact originate in Caracol. The literature is rich with explanations of stable isotopes and the writings of a few stalwarts in the field were utilized to gain an understanding of the associated technologies and techniques utilized in its analysis. Data from the Copan (Whittington and Reed 1997) and Caracol (Chase and Chase 2001) stable isotope studies were utilized to show the application of stable isotope analysis in areas "associated" with K'inich Yax K'uk Mo' and to illustrate how the palace diet identified by Chase and Chase (2001; Chase *et al*. 2001) could be aligned with the Stuart hypothesis to predict the stable isotope ranges for K'inich Yax K'uk Mo'.

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INTRODUCTION

According to the ascension story on Copan's Altar Q, K'inich Yax K'uk Mo', founder of the dynasty that ruled Copan through the Late Classic period (Fash 2001; Martin and Grube 2000; Schele and Friedel 1990; Stuart 1996, 2004; Webster, Freter, and Gonlin 2000), was crowned elsewhere and then journeyed on to Copan to take his throne (Martin and Grube 2000:192-193). This account was dismissed as myth until his presumed remains were found (Sharer *et al.* 1999:7) and subjected to a life history analysis (Buikstra *et al.* 2004) which indicated that his early years had been spent outside of Copan. That analysis could not, however, pin down his point of origin. Three years after publication of the Buikstra *et al.* (2004) study, Stuart (2007) advanced a hypothesis that K'inich Yax K'uk Mo' originated from Caracol and was, in fact, a Caracol lord, despite there being no supporting archaeological evidence.

Stable isotope analysis has been utilized by the archaeological community to study a wide range of ancient activities (Larsen 2002:122) including the diet of specific ancient Maya communities. Dietary stable isotope analysis has not, to this date, been conducted on the purported K'inich Yax K'uk remains. In this study, I propose to use Caracol stable isotope data to predict K'inich Yax K'uk Mo's carbon and nitrogen stable isotope measures at death if he did in fact originate from Caracol. While not being incontrovertible proof, if/when stable isotope analysis of K'ininch Yax K'uk Mo' is actually conducted, and the results support the predictions of this study, it would significantly increase the likelihood that he did, in fact, hail from Caracol.

The Problem

In a weblog posting, Stuart (2007:1) advanced a theory that K'inich Yax K'uk Mo' was a Caracol (Figure 1) lord prior to coming to Copan as the founding dynast. Stuart has identified a special title – 3-Witz-a or “Three Hills Water” – on K'inich Yax K'uk Mo's name glyph on Stela 63. According to Stuart, K'inich Yax K'uk Mo' is referred to as “Three Hills Lord” on Stela J (Stuart 2007:1). Three-Hills-Water is a place name identifiable with Caracol (Chase *et al*. 1991; Grube 1994:107) where “... Three-Hills-Water is cited as a local name in both Ealry (sic) and Late Classic inscriptions, and rulers of Caracol are often portrayed standing atop animate witz mountains wearing the headband of the number 3 ...” (Stuart 2007:1-2). Stuart also points to an “odd” ceramic connection between Belize and Copan, and the “unusual” mention of a later Copan ruler on Caracol's Stela 16, as further evidence in favor of his position (Stuart 2007:2).

Price *et al.* (2010:23) refer to Stuart’s conclusion as justified but do not offer any additional supporting arguments. The authors further point out the lack of supporting archaeological material that links founding period Copan to Caracol (Price *et al.* 2010:21); rather, they argue that the available archeology links K’inich Yax K’uk Mo’ to Tikal (Price *et al.* 2010:21). The authors get around this conundrum by proposing that K’inich Yax K’uk Mo’ was born a Caracol Lord but moved to the royal palaces in Tikal at a young age and launched his takeover of Copan as an agent of Tikal (Price *et al.* 2010:21). The evidence for a K’inich Yax K’uk Mo’ association with Tikal is, as the authors admit, circumstantial at best (Price *et al.* 2010:21).

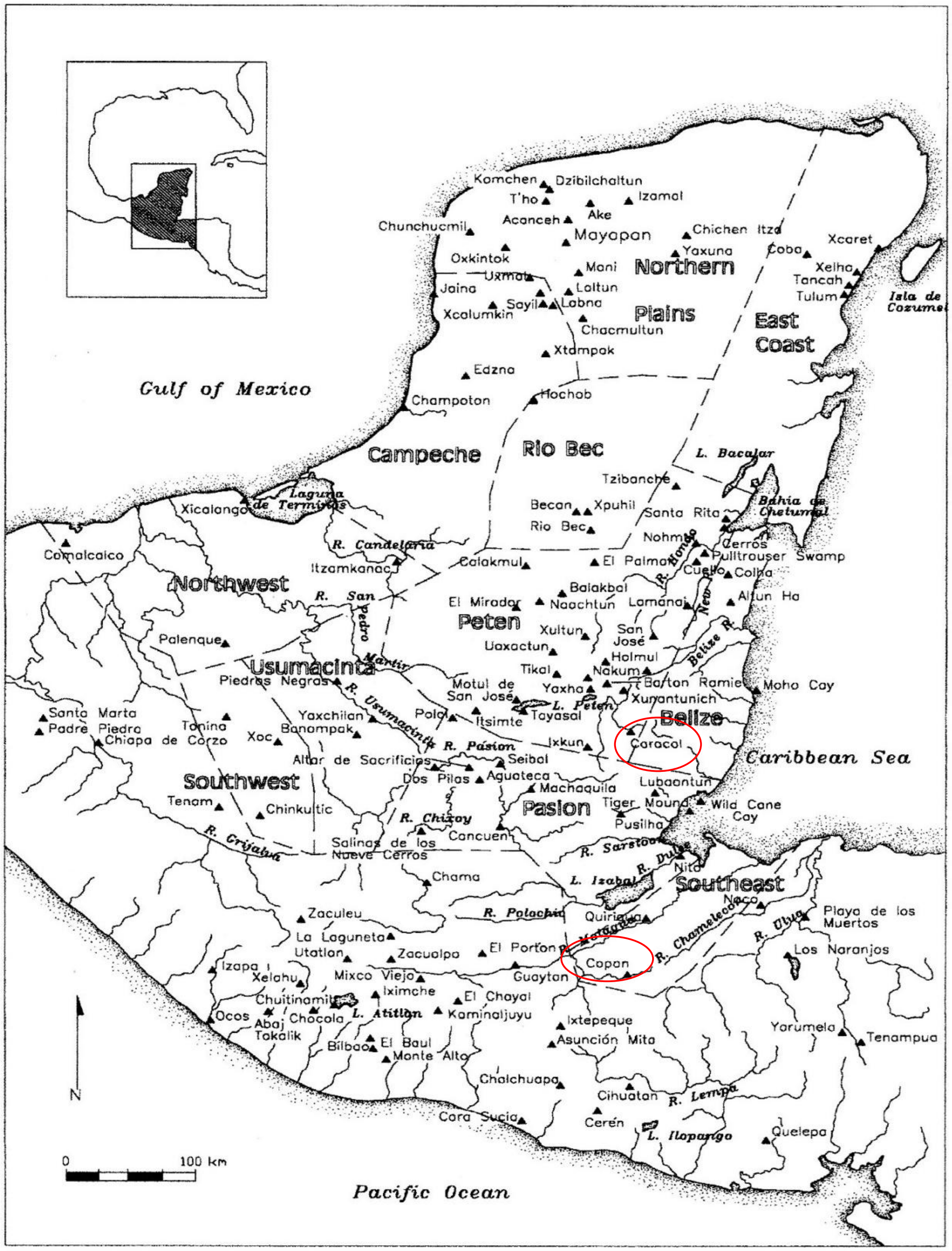

Figure 1. Map of the Maya area with Copan and Caracol indicated. (Source: Brown and Witschey, Figure 1)

In that K'inich Yax K'uk Mo' was the progenitor of the Classic-period Copan dynasty, it would be helpful to know his polity of origin. Such insight would allow us to better understand the context of his actions at Copan and would also help to shed light on the origin city based on his actions at Copan. One potential mechanism for identifying his polity of origin would be to map his stable isotope measures against known stable isotope data in order to make a determination. Price *et al.* (2010) conducted oxygen and strontium stable isotope analyses on a number of Copanec skeletons, including the putative K'inich Yax K'uk Mo remains, and mapped those results to known regional stable isotope measures. K'inich Yax K'uk Mo's origin could not be narrowed beyond the central Peten. Carbon and nitrogen stable isotope analyses for K'inich Yax K'uk Mo have not been reported to date. In this study I propose to use Stuart's hypothesis, broadly available data, and scientific facts to predict the carbon and nitrogen stable isotope measures for K'inich Yax K'uk Mo'.

Study Approach

This study will utilize stable isotope data from Caracol (Chase and Chase 2001) and Copan (Gerry 1997; Tykot 2002; Whittington and Reed 1997), and known collagen-turnover rates, to predict K'inich Yax K'uk Mo's carbon and nitrogen stable isotope measures at time of death.

The first step in this study will be to examine the evidence for K'inich Yax K'uk Mo's relevance and non-Copanec origin. Once those steps are completed we will turn to an examination of stable isotope technology, its use in archaeology, and an examination of its use in the Maya areas as an investigatory tool. Any relevant analytic data will be collected and assessed in this phase. Finally, we will show how the available data can be used to predict K'inich Yax K'uk Mo's stable isotope measures, if he did indeed originate from Caracol.

K'INICH YAX K'UK MO' AND HIS PLACE IN COPANEC HISTORY

Copan

The Copan River flows in a south-westerly direction from its headwaters 1100 meters above sea level in the northwest portion of Honduras before becoming the Camotan River and flowing into the Motagu River in Guatemala. The terrain through which the Copan River meanders is mountainous and the river's descent is steep, as indicated by a difference of 550 meters in height from the headwaters to the river's end. At five different spots along its shallow course the Rio Copan widens out to form areas of deep alluvial soil called "pockets." The largest of these pockets, the Copan Pocket, 12.5-km long and 4-km wide, is the home of Copan, one of the most well-known and researched Maya sites in Mesoamerica. While the most important habitation zone in the Copan Pocket has long been associated with the alluvial bottomlands, settlement sites have also been identified in adjacent terraces and along Copan River tributaries (Canuto *et al*. 2004:3).

Archaeology at Copan

Copan Chronology

Dates of occupation at Copan were initially established based on ceramic sequencing by Longyear (1952) and extended by Viel (1990; Fash 2001:Figure 5). An even more recent Viel sequencing effort (1993) pushes the earliest known occupation at Copan back to around 1400 BC, almost 400 years earlier than initially estimated.

Based on epigraphic data, Copan scholars have shown that the city was ruled by a dynasty of 16 kings beginning with the founder K'inich Yax K'uk Mo' in AD 426. Dynastic rule terminated with the collapse of the dynasty and rapid depopulation of the valley (Fash 1986:84). This ending date was fixed by a "... cessation of dated monuments and lack of a recognizable Post-Classic ceramic assemblage" (Fash 1986:84). There is a still-ongoing debate (Freter 1992; Braswell 1992; Fash and Sharer 1993; Webster, Freter, and Rue 1993) as to how much time elapsed between the demise of the dynasty and valley depopulation. The resolution of this argument has significant implications for Copan population estimates. For example, if Freter's (1992) dating technique is not accepted, then "population estimates based on Freter's work may have to be revisited because if the dates cannot be pushed back then the population was larger in the shorter period" (Braswell 1992:142).

Settlement Pattern Studies

Table 1 provides the view of population distribution resulting from the Copan Archaeological Study, Phase I, (PAC I) settlement analysis. The population levels, and associated political organization (see Fash 1986:91-93), are based on pottery sherd counts from the relevant contexts. According to Fash (1986:93), the study had "... documented a gradual rise in complexity and density of settlement from the Early Preclassic up through the Late Classic period ..." Fash (1986:93). It was in the Late Classic period that population and socio-political control would reach its peak (Fash 1986:93). Table 1 shows a revision of the rapid depopulation of the valley originally espoused by Fash (1986:84).

Table 1. PAC 1 Copan Population Levels by Period

Period	Dates	Population Levels
Uir (Middle Preclassic)	825BC – 650BC	Evidence of settlement
Chabij (Late Preclassic)	150BC – 49AD	Drastic reduction in population
Bijac (Early Classic)	50AD – 380AD?	Limited population
Transition Bijac/Acbi		Population reduction
Acbi (Middle Classic)	400AD – 599AD	Significant population increase; competing polities
Coner (Late Classic)	600AD – 899AD	Apogee of size and power; 15,000 – 20,000 population
Ejar (Postclassic)	900AD – 1200AD	Abandonment

Source: Compiled from Fash (1986:76-84) and Freter (1992).

The second phase of the Copan Archaeological Project (PAC II) was initiated in 1980 under the co-directorship of William T. Saunders and David Webster. Fash and Sharer (1991) take issue with a number of the findings of the PAC II survey. First, the PAC II team shows nucleation beginning in the AD 550-700 period while Fash and Sharer show nucleation beginning hundreds of years earlier in the 4th century AD. The problem, as these authors see it, is that the PAC II team is applying results from a rural setting to reach conclusions about Copan as a whole and, in so doing, they are ignoring the extremely important urban core data (Fash and Sharer 1991:167). Fash and Sharer also take issue with the sampling methodology because of a perceived bias towards the Late Classic as a result of only sampling visible structures. “Thus, while the results obtained may be valid for the Late Classic Coner occupation, they may not be necessarily representative of the pre-Coner phase settlement history of Copan” (Fash and Sharer 1991:173). The Pac II team sampled 14% of the sites and, while that was probably statistically valid for the Coner phase, “... the adequacy of the sample based on surface sites is belied by the PAC I finding of deeply buried pre-Coner material” (Fash and Sharer 1991:177). Further, the practice of two test pits per site was not sufficient to rule out pre-Coner occupation at any site; for example, two seasons of excavations were undertaken at Group SL-12 before pre-Coner occupation was revealed.

Fash and Sharer (1991) and the PAC I data allow for a K'inich Yax K'uk Mo' in Copan while the PAC II data, with nucleation assumed to have begun after AD 550, does not.

Pre-K'inich Yax K'uk Mo' Copan

Archaeological Considerations

Preclassic (1410 BC - A.D. 400) inhabitants of the Copan region did not exhibit active land management practices. The inhabitants planted subsistence crops in the alluvial soils found in the Copan bottomlands but were subject to the depredations of the river during course changes or flooding episodes (Hall and Viel 2004:27; Traxler 2004:56). Archaeological evidence indicates an influx of population to the area during the Late Preclassic, a surprising occurrence given the "… areas vulnerability to inundation" (Schortman and Urban 2004:323). Riverine activity did not deter the floodplain settlers as evidenced by settlement relocations in response to this force of nature (Traxler 2004:57).

Evidence of prehistoric occupation is hard to recover at most Maya sites because it either exists beneath a modern-day city or later Maya remains. Copan is no exception. The earliest known house uncovered at Copan has yielded ceramics which led to the establishment of the Rayo Early Preclassic ceramic complex (Fash 2001:65). This house, uncovered as part of the PAC I study effort, yielded artifacts that showed that maize and animals contributed to the diet of the residents. The ceramics recovered indicate that the Copanec population looked at non-Maya sites for direction. "The earliest Copan ceramics contain forms and decorative modes that clearly associate them with ... the Pacific Coast and adjacent uplands of Chiapas and Guatemala, as well as Chalchuapa in El Salvador" (Fash and Stuart 1991:149-150).

The first stone architecture at Copan is dated to about 1100 BC and is to be found above and west of the location of the "Rayo-complex" house (Fash 2001:66). "This was an earth-filled, cobblestone-faced platform with Early Preclassic ceramics" (Fash 2001:67). The ceramics were found in sub-floor burials and were incised with complex religious imagery. According to Fash and Stuart (1991:50), "the presence of complex ("Olmec") iconography on burial ceramics from Copan ties in with evidence for participation in the Olmec symbol system which is strongly visible at Pacific Coast and Piedmont centers such as Abaj Takalik." In addition to the ceramics, some of the burials to the south of the platform contained jade accompaniments, and one particular burial (VIII-27) had offerings that "... represent a deposit of unprecedented wealth in the Maya area at this early date ..." (Fash 2001:70). Fash concludes that, "... the presence of such offerings, and the complex set of religious beliefs and icons represented in the incised ceramics, indicates a level of social and economic organization above that of simple peasant agriculturists" (Fash 2001:70).

The instability of Preclassic settlement in Copan was supplanted by the emergence of a relatively stable settlement during the Protoclassic-Early Classic period (Traxler 2004:57; Schortman and Urban 2004:327) but it was in the period A.D. 400-425 that the signature of elite direction of labor can be observed (Traxler 2004:57). It was during this period that the cobble structures of earlier times were covered by extensive terraces, the subsequently important Yune platform, and early examples of patio groups, some of which were isolated by earthen and cobble walls. The architecture of this period reflected elite direction as well as a "… change in the organization and functions of architecture” (Traxler 2004:58).

Epigraphic Considerations

In the case of Copan, the epigraphic record is more date- and ritual-oriented than historical in nature (Stuart 1996:3). It is widely accepted that the Copan dynasty begins with the accession of K'inich Yax K'uk Mo' in 8.19.10.10.17 (September 6, AD 426) (Fash 2001:79; Martin and Grube 2000:192; Schele and Friedel 1990:311; Stuart 2004:216; Webster, Freter, and Gonlin 2000:23), but it is also clear that he was not the first king at Copan nor the earliest retrospective reference on Late Classic monuments. Stuart (2004:16) refers to a Predynastic era which is defined by six dates from Late Classic inscriptions:

Table 2. Dates Defining Copan's Prehistoric Period

Long Count	Calendar Round	Gregorian Equivalent	Source
7.1.13.15.0	9 Ajaw 13 Kumuku	October 14, 321 B.C.	(Altar I)
8.6.0.0.0	10 Ajaw 8 Ch'en	December 18, AD 159	(Stelae 1 and 4)
8.6.0.10.8	10 Lamat 16 Pop	July 13, AD 160	(Stela 1)
8.10.10.10.16	9 Kib 4 Pax	April 6, AD 249	(Doorjamb, Structure 10L-7)
8.17.0.0.0	1 Ajaw 8 Ch'en	October 21, AD 376	(Peccary skull, Tomb 1)
8.19.0.0.0	10 Ajaw 13 K'ayab	March 25, AD 416	(Stela 15)

The 321 BC reference is found on Altar I but Stuart (2004:216) sees it as being too early to be considered a part of Copan's prehistory. The AD 159 date is recorded on Late Classic inscriptions from Stelae 1 and 4 and seems to have been an especially significant date for the city (Stuart 2004:216; Schele and Friedel 1990:309). Stela 1 also records the July 13, AD 160 date in association with “... the glyph that signifies Copan both as a physical location and a political entity” (Schele and Friedel: 1990:309). The area on the glyph that recorded the event is now destroyed. According to Fash and Stuart (1991:53), Stela 24, which has an initial series date of

9.2.10.0.0 (AD 485), refers to the "first to be seated as ahau" yet the glyphic name on the stela is not that of Yax K'uk Mo'. On Stela I, the 7th ruler refers to Yax K'uk Mo' as successor to Smoke Codex God K (Fash 2001:87). Schele and Friedel (1990:311) surmise that K'inich Yax K'uk Mo' "... earned the designation as founder because he exemplified the charismatic qualities of the divine ahau better than any of his predecessors."

Arrival of K'inich Yax K'uk Mo'

K'inich Yax K'uk Mo's arrival at Copan was truly transformational for the contemporary residents of the Copan pocket and reverberated through the entire history of the dynasty. According to Stuart (2004:225), "upon his arrival and subsequent celebration of the Bak'tun ending, Copan emerged as a literate society in the Lowland Maya tradition, with novel emphasis on stone monuments and the presentation of permanent written records."

Accession to Power

The story of K'inich Yax K'uk Mo's accession to power at Copan is detailed on Altar Q, a monument of Yax-Pac, the 16th ruler in the dynasty. The front of the altar has a picture of K'inich Yax K'uk Mo' handing the insignia of authority to Yax-Pac with all of the intervening kings occupying positions around the remainder of the altar in the order of their rule. The events surrounding K'inich Yax K'uk Mo's ascension are recorded on the top of the altar. According to Yax-Pac, K'inich Yax K'uk Mo' took the God-K scepter of royal authority on September 5, AD 426 and three days later he "arrived" at the "Foundation House" as the founder of the lineage (Fash 2001:79; Harris 1999:23; Marcus 2003:94; Martin and Grube 2000:192-193; Schele and Friedel 1990:311). These events occurred at a location other than Copan because 152 days had elapsed before he finally arrived at the city (Marcus 2003:95; Martin and Grube 2000:192-193). According to Harris (1999:23), the God-K scepter was received at a place called Ch'okte Na and this event, as well as K'inich Yax K'uk Mo's arrival at the "Foundation House" three days later, is recorded on Zoomorph 7 at Quirigua.

Hidden in the text of Altar Q is the story of a foreign usurper who employed military campaigns to subjugate Copan (Marcus 2003:95; Sharer 2003:158) and to install an acolyte at nearby Quirigua. There is ample evidence to support both a non-Copan origin and a military background for K'inich Yax K'uk Mo'. First, a strontium isotope analysis by Buikstra *et al.* (2004) of the skeleton found in the Hunal tomb – a skeleton that is thought to be the final remains of K'inich Yax K'uk Mo' (Sharer *et al.* 1999:7) -- found that the person in the tomb had not spent his youth in Copan but was, instead, from the central Maya lowlands. Marcus (2003:95) points to the survival injuries associated with the same skeleton which show that, while alive, the personage had experienced three broken ribs (healed), a parry fracture of the right forearm (partially healed), a fractured scapula (partially healed), and a broken fifth metacarpal. These injuries "… present clear evidence of severe, survived blunt force trauma" (Buikstra 2003:6).

Legitimization

The traditional mechanism for ruler legitimization in the contemporary Maya period was ancestor veneration (Braswell 2003:38). Ancestor veneration in Classic Maya society positioned dead relatives in continuing contributory roles. Ancestors "… validated political power, status and access to resources. Moreover, as facilitators of power transfers between the generations, ancestors played a particularly critical role in times of social transformation …" (McAnany 1998:272).

Such an avenue for legitimization was not available to K'inich Yax K'uk Mo' so he sought other avenues for self-legitimization (Marcus 2003:95). One avenue of legitimization available to K'inich Yax K'uk Mo' was demonstration of nobility of birth and the Hunal remains exhibit rather prominent cranial deformation and filed teeth with jadeite inlays (Marcus 2003:95), both evidence of nobility in ancient Maya societies. The second self-legitimization technique employed by K'inich Yax K'uk Mo' was his apparent marriage to a local noblewoman (Marcus 2003:96; Sharer 2003:158). The purported skeleton of K'inich Yax K'uk Mo' was recovered from the structure called Hunal which was buried under Yehnal, a funerary shrine dedicated K'inich Yax K'uk Mo' (Sharer *et al* 1990:10). Yehnal was, in turn, terminated and buried under a new substructure called Margarita. Margarita was constructed in a manner which provided access from a burial chamber on its floor to a vaulted burial chamber in the Yehnal substructure. A burial found in this lower chamber (along with rich accompaniments in both the upper and lower chambers) was presumed to be the former wife of the founder K'inich Yax K'uk Mo'. Strontium isotope analysis has shown that the occupant of this tomb spent her early life in Copan, leading to a hypothesis that Yax K'uk Mo' had solidified/legitimized his position by marrying the most important woman in Copan (Nielsen 2006:2).

The third and, perhaps, most powerful technique of legitimization deployed by K'inich Yax K'uk Mo' was the introduction of Teotihuacan-derived imagery. "… the Teotihuacan-derived imagery of Copan and Tikal reflects an ideological alignment more than a true military alliance. That is, the kings of both polities used a vigorous, new, elite mythology to legitimize their tenuous grasp on power" (Braswell 2003:38). Without the ability to lay claim to the legitimacy associated with dynastic alignment, the source of legitimacy since Preclassic times, association with the "metaphysical place of reeds" (the mat house referred to in the ascension story?) was a fitting substitute (Braswell 2003:38). Once K'inich Yax K'uk Mo's son became king, he reverted to the more common practice of ancestor veneration and Teotihuacan-derived imagery became a thing of the past (Braswell 2003:38).

Architecture

Architectural change as a result of K'inich Yax K'uk Mo's accession to the Copan throne is very evident in the archaeological record. According to Marcus (2003:96), "K'inich Yax K'uk Mo' evidently brought the template of a powerful preexisting state with him and established a grand architectural plan that was maintained throughout the history of the Copan Acropolis." Prior to K'inich Yak K'uk Mo's arrival at Copan, the architecture reflected southeastern traditions but after his installation a number of lowland Maya elements begin to intrude. For example, no lowland Maya portrait monuments are evident prior to the K'inich Yak K'uk Mo' portrait on the Motmot Marker, and it is lowland both in style and material. Second, the Hunal temple has a "low masonry substructure with undecorated *talud-tablero* facade," an arrangement which is reminiscent of the well-known central Mexican style (Sharer 2004:303). The influences are further emphasized when the author points out that the Hunal proportions are Teotihuacan-type while the masonry construction techniques are associated with the Maya lowlands.

External Influence

K'inich Yax K'uk Mo's installation and reign provided extensive evidence of imitation of Teotihuacan, possibly involving an intermediary such as Tikal or Kaminaljuyu (Sharer 2004:300; Fash and Stuart 1991:154). "The preponderance of slab-footed tripod vessels, polished blackwares, and incised vessels bespeaks intensive and sustained commercial interaction with the highlands ..." (Fash and Stuart 1991:154). Sharer asserts that Teotihuacan had links with Tikal prior to the Copan founding and, therefore, if he came from Tikal, he would likely bring along advisers and paraphernalia which reflected the Teotihuacan influence (Sharer 2004:300). Sharer sees the contemporary founding of Quirigua as an attempt by Tikal to control the Motagua obsidian and jade trade and exerting influence on Copan would allow Tikal "... better access to the markets and resources of Central America" (Sharer 2004:300).

Legacy

The archaeology of the Copan Acropolis was investigated by the Early Copan Acropolis Project (ECAP) directed by William Sharer. ECAP ran from 1989 to 1996 when excavation ceased as a result of reaching "... the base of the Acropolis architectural sequence and a self-imposed limit on the lateral extent of our excavations" (Sharer *et al* 1999:3).

Prior to the establishment of the royal structures, the site of the present-day Acropolis was the location for a Terminal Preclassic-Early Classic residential complex whose structures consisted of low uncut cobble-faced platforms (Sharer *et al* 1992:151; 1999:5). The first evidence of regal-style construction corresponds to the period of the arrival and ascent to the throne of K'inich Yax K'uk Mo'.

Archaeological research shows that the royal complex began its life as three separate but proximate groupings: The Mini-Acropolis of the South (MAS); the Northeast Court Group; and the 10L-26 sub-Group (Sharer *et al* 1999:5). These buildings were subsequently linked by a plaza and then fully integrated into a precursor of the current Acropolis in approximately A.D. 540. The present-day Acropolis grew out of the MAS cluster, the first stage of which is built on the Yune platform. One of the better known of the four buildings that graced this platform has been nicknamed Hunal by the project archaeologists. This building is unique in Early Classic Copan because of its *talud-tablero* styling, a feature that maybe central Mexican in origin. This architectural style is one of the lines of evidence that tie Hunal to the founder of the dynasty.

Ruler 2, the son of K'inich Yax K'uk Mo', initiated a number of projects aimed at venerating his father's memory. The Xucpi Stone was "... a carved monolith found reset in the wall of an elaborate Early Classic royal tomb in the MAS complex" (Sharer *et al* 1999:10). The stone is believed by scholars to have been initially created for the tomb of Yax K'uk Mo' and set in the Yehnal structure for that purpose. The text on the Xucpi Stone indicated that it had been dedicated by Ruler 2 on November 30, 437 AD, in honor of his father. Based on the dedication date, scholars assume that Yax K'uk Mo' died in 437 AD.

After establishing his father's legacy in the Xucpi Stone text, Ruler 2 then ties himself to that greatness in the Motmot Marker. The Motmot Marker, a carved circular monument, was discovered in 1992 in excavations below the 10L-26 Subgroup. The Motmot Marker had been placed in front of an Early Classic substructure called Motmot by the team. The marker has the likenesses of the founder and Ruler 2 separated by a vertical band of text that identifies the protagonists and commemorates the 9.0.0.0.0 period-ending ceremonies (Sharer *et al* 1999:9)

The Margarita structure, final resting place of the purported wife of the founder, had its western facade “... adorned by stucco-modeled panels on both sides of its outset stairway. Each of these panels displayed an elaborate full-figure emblem of the founder's name, surrounded by the symbols of the universe and apparently sacred locations ...” (Sharer *et al* 1999:10).

The construction efforts of Ruler 2 were continued to greater or lesser degrees by the subsequent kings of the dynasty with the pace of expansion commensurately greater in the Early Classic than in the Late Classic (Sharer *et al* 1999:19).

CARACOL

Since Stuart's (2001) thesis is that K'inich Yax K'uk Mo' originated from Caracol; thus, it behooves us to provide a brief picture of Caracol both as we see it today and as it was in K'inich Yax K'uk Mo's time. This section will draw heavily on the work of Drs. Arlen F. and Diane Z. Chase who have spent over a quarter of a century bringing Caracol "back to life." The complete corpus of the Chases' work can be found at www.caracol.org.

Discovery and Archaeological Activity

The ruins of ancient Caracol are located in the Cayo district of the small, English-speaking Central American country now called Belize (formerly British Honduras). The ruins were first discovered in 1938 by a Belizean woodcutter named Rosa Mai (Chase and Chase 1987:1), who immediately informed the Belizean authorities. A.H. Anderson, the Belizean Archaeological Commissioner investigated the site in 1938 and located stone monuments and mounds in addition to conducting preliminary studies of some architectural constructs (Chase and Chase 1987:1).

Anderson's preliminary work in 1938 was the last activity at Caracol until Linton Satterthwaite undertook a three-week expedition in 1950. Satterthwaite returned to Caracol in 1951 and 1953 to conduct mapping and photography exercises. P. H. Anderson, who had accompanied Satterthwaite on his 1953 trip, returned to Caracol in 1955 and 1958 and worked on the South Acropolis in the A Plaza (Chase and Chase 1987:2).

Between Anderson's work and the beginning of the monumental, 28-year effort by the Chases of UCF, Caracol really only saw investigations of its terraces in 1980 by Paul Healy

(Healy *et al*. 1983). Beginning in 1983, and continuing until today, the Chases have methodically peeled back layers of ruins to reveal the secrets of this ancient society. The work continues.

The Caracol Tourism Development Project ran concurrently with the Caracol Archaeological Project over the 2003-2004 field seasons (Chase and Chase 2003, 2004). The objectives of this project, directed by Dr. Jaime Awe, were cleaning, artifact processing, and final stabilization of the buildings around the South Acropolis.

<u>Caracol Chronology and Population</u>

Due to the size of the ancient city, and the difficulty of gaining access to the levels housing relevant artifacts, relatively little is known about Caracol's Preclassic and Early Classic periods. From what little they have been able to cull from the site the Chases conjecture that areas within the region had been occupied by at least 600 BC (Chase and Chase 2005:33) and that by A.D.100 all of the major epicentral groups were experiencing major construction activity. Further, while the city had relatively low population levels in both the Preclassic and Early Classic periods (Chase and Chase 1987:2), ritual caches dated to the Preclassic point to Caracol as a "… Preclassic *may ku* – major center – that hosted important cyclical ceremonies …" for a large part of the Southern Peten (Chase and Chase 2006:54). According to the Chases, "The richness and diversity of Caracol's caches contrast greatly with caches of similar date from Tikal and Uaxactun and also provides precedent for the caching patterns found at those key sites much later in the Early Classic Period" (Chase and Chase 2006:54).

The ancient city reached its apex, both culturally and architecturally, during the Classic

Period (AD 250 – 900). It was during this period that the dynasty which ruled through the Classic Period was founded (AD 331) and the major identifying characteristics of the city (epicentral palaces, causeway system with terminal buildings, extensive agricultural terracing) began to take their "modern" form. The population is believed to have numbered over 100,000 at its peak (Chase and Chase 1994).

STABLE ISOTOPE ANALYSIS

Stable isotope analysis will be the linchpin of this study effort and, as such, will be the focus of this section.

Stable Isotopes

Archaeological Relevance of Stable Isotope Analysis

The process of determining prehistoric diet is based on an understanding of the in-place flora and fauna (Schwarcz and Schoeninger 1991:305; Larsen 2002:120) and a reconstruction of individual diet through specific types of skeletal analysis. Knowledge of the flora and fauna provides insight into the availability of food types, but does not shed light on how much of each food type is consumed (Larsen 2002:120; Chisholm 1989:10). The role of determining the contributions of specific foods to the overall diet is filled by bone chemistry analysis. "The most important breakthrough in dietary and nutritional status is analysis of ratios of specific stable isotopes in skeletal and dental tissues of past populations" (Larsen 2002:121). Stable isotope analysis has empowered archaeologists to develop testable hypotheses in the areas enumerated in Table 3.

Table 3. Insights Afforded by Stable Isotope Analysis

Consumption of marine and freshwater foods
Dietary access in relation to status
Infant feeding and weaning patterns
Residence
Individual migration
Population movement
Climate reconstruction

Source: Compiled from Larsen 2002:122.

Isotopes

The nuclei of most elements existing in nature are composed of protons and neutrons. Isotopes of those elements have a similar number of protons but differ in the number of neutrons. To illustrate, the element hydrogen (H) has three naturally occurring isotopes ^{1}H, ^{2}H, and ^{3}H. ^{1}H, sometimes called protium, has a single proton in the nucleus; ^{2}H (deuterium) has one proton and one neutron in the nucleus; and ^{3}H (tritium) has one proton and two neutrons in the nucleus. Isotopes of an element can be either stable or unstable (subject to radioactive decay). One of the key differentiators is that the relative abundance of a stable isotope will be fairly constant from sample to sample (Schwarcz and Schoeninger 1991:288). The stable carbon isotopes ^{13}C and ^{12}C have natural abundances of 1.1% and 98.9% respectively. Samples taken at different spatial and temporal loci should yield similar abundances for an isotope to be labeled stable.

Utility of Stable Isotopes as Paleodiet Indicators

In that chemical reactions occur outside the nucleus, the different isotopes of an element have similar chemical properties (Schwarcz and Schoeninger 1991:287). The isotopes of the element differ in mass, however, and this can lead to "… different kinetic and thermodynamic properties (i.e., differences in rates of reactions and in heat capacity) when they undergo chemical reactions" (Schwarcz and Schoeninger 1991:288). These differences in rates of reaction can lead to what is termed "isotopic fractionation." Isotopic fractionation occurs when the isotope ratios of the products of a reaction or series of reactions differ from the ratios of the reactants (DeNiro 1987:182; van der Merwe 1982:596; Schwarcz and Schoeninger 1991:288). For example, the $^{13}C/^{12}C$ ratio of atmospheric CO_2 is larger than that of photosynthetically produced cellulose. Hence, there is a fractionation between substrate (CO_2) and the product

(Cellulose) (Schwarcz and Schoeninger 1991: 288).

Isotopic abundance in a substance is calculated (Schwarcz and Schoeninger 1991:289):

$$\delta^{E}(X) = (R_x/R_s\text{-}1)1000\ ‰ \tag{1}$$

where

E = element,
R_x = isotope ratio in sample, and
R_s = isotopic ratio in standard.

In the case of carbon, the above would be represented as (van der Merwe 1982:596):

$$\delta^{13}C = \left(\frac{\dfrac{\text{Amount of } ^{13}C \text{ in sample}}{\text{Amount of } ^{12}C \text{ in sample}}}{\dfrac{\text{Amount of } ^{13}C \text{ in standard}}{\text{Amount of } ^{12}C \text{ in standard}}} - 1 \right) \times 1000‰ \tag{2}$$

According to Schwarcz and Schoeninger (1991:302), "the utility of stable isotopes as paleodiet indicators arises principally from the differences in isotope ratios of various dietary substrates (food and drink) … for carbon and nitrogen, such differences were linearly related to differences in $\delta^{13}C$ and $\delta^{15}N$ of tissues and whole organisms." How is this so? The tissues of the human body are composed of carbon, hydrogen, nitrogen, sulfur, oxygen, and phosphorous atoms and all, with the exception of phosphorous, have stable isotopes (Schwarcz and Schoeninger 1991:291). If a human being consumes a stable diet over a period of time that is long compared to tissue turnover, then body tissue will attain an isotope ratio steady state which will differ from the isotope ratio of the dietary intake (Schwarcz and Schoeninger 1991:291). Stable carbon and nitrogen isotope ratios are well-suited to the identification of food consumption and further identifies the relevant isotopes as surviving in bone, bone collagen, and tooth enamel (Schwarcz and Schoeninger 1991:285).

Bone and Bone Collagen

Bone is important in that all of its components contain carbon and/or nitrogen, key material for dietary studies, and 90% of its organic matrix is collagen whose insolubility ensures some material survival even in the cases of degraded bone (Schwarcz and Schoeninger 1991:226). Because the turnover rate of collagen is approximately ten years, diet information obtained from collagen analysis is an average of several years consumption (Schwarcz and Schoeninger 1991:285; Tykot 2002:3). In more recent research, Hedges and colleagues (2007) have shown that collagen turnover in the femoral mid-shaft is higher during adolescent years than later in life. Their results show that collagen turnover can range between 10% and 30% at ages 10 to 15 but, for males, decline to 3% at age 25 and 1.5% at age 80 (Hedges et al 2007:814). According to the authors, "… for turnover rates of 2%/year after age 25, even at age 50 years there is a 40% representation of collagen synthesized at age less than 25 years" (Hedges et al 2007:815). Femoral mid-shaft data thus allows us an "ice-core" opportunity in the study of origins even after the collagen window has closed.

Carbon and Nitrogen Entry into the Biological System

Both carbon and nitrogen are key indicators of past diet. Carbon resides in the ocean as dissolved bicarbonate ($\delta^{13}C \simeq 0‰$) and in the atmosphere as CO_2 ($\delta^{13}C$ = -7 to -8‰) (van der Merwe 1982:599; Schwarcz and Schoeninger 1991:303). Carbon enters the biological system from the atmosphere through photosynthesis by green plants and from the ocean through chemosynthesis by bacteria involved in symbiotic relationships with organisms residing in proximity to deep sea vents. Both photosynthesis and chemosynthesis shift the $^{12}C/^{13}C$ ratio in living organisms relative to the source carbon ratio (Schwarcz and Schoeninger 1991:303). Terrestrial plants depend on atmospheric CO_2 as their primary carbon source while marine organisms source their carbon from terrestrial detritus, dissolved CO_2, and dissolved carbonic acid (Schwarcz and Schoeninger 1991:303).

Almost 100% of exchangeable nitrogen is found in the atmosphere or dissolved in the world's oceans (Schwarcz and Schoeninger 1991:304). The nitrogen is transferred from these environments into the biological system through the processes described in Appendix 3. Terrestrial plants have $\delta^{15}N$ values close to atmospheric N_2 because nitrogen uptake is a result of fixation of atmospheric N_2 through soil bacteria. Marine plants gain their nitrogen from bacterial and algal fixations and generally have higher $\delta^{15}N$ values than terrestrial plants (Schwarcz and Schoeninger 1991:304).

Isotopic Fractionation

Isotopic fractionation has previously been described as having occurred when the isotopic ratios of the products of a reaction, or series of reactions, differ from the ratios of the reactants (DeNiro 1987:182; van der Merwe 1982:596; Schwarcz and Schoeninger 1991:288). Carbon isotopic fractionation occurs in both the terrestrial and marine environments.

"All animals ultimately obtain their nutrients from plants" and, in so doing, inherit the isotopic signatures of the differing photosynthetic pathways (Schwarcz and Schoeninger 1991:303; van der Merwe 1982:596). Terrestrial plants have three photosynthetic pathways: C3, C4, and Crassalucean acid metabolism (CAM). The characteristics of these pathways are highlighted in Appendix D. As can be seen from the table, the C3 and C4 pathways are named for the number of carbon atoms that appear in the earliest post-fixation metabolites. Appendix D also shows greater (less negative) values for C4 plants, a result of the differing kinetic isotope effects between the two enzymes. "In principle, the $\delta^{13}C$ of each plant type is controlled by these kinetic isotope effects and the $\delta^{13}C$ of atmospheric CO_2 "but, in reality, factors such as light levels and moisture can cause variation" (Schwarcz and Schoeninger 1991:303).

The differences in $\delta^{13}C$ between C3 and C4 plants allows us to make a determination of the proportionate contribution to diet based on the $\delta^{13}C$ of preserved tissue. It should be noted that consumption of herbivores by humans allows the $\delta^{13}C$ values of the C4 grasses consumed by the herbivore to be transferred to the human tissue.

Most of the carbon available to marine organisms results from phytoplankton photosynthetic activity. Most planktonic species have $\delta^{13}C$ values that fall between that of C3 and C4 plants and that is reflected in the $\delta^{13}C$ values of marine vertebrates.

Terrestrial C3 plants are depleted in ^{13}C by about 7‰ in relation to marine plants and animals and this signature can be used to differentiate between these foods in paleodiets.

Stable Isotope Analysis

Stable isotope analysis is conducted by a mass spectrometer wherein the isotope ratio of a sample is measured and then compared to the isotope of a standard (Schwarcz and Schoeninger 1991:290). Prior to the measurement process, however, the sample has to be selected and prepared. As mentioned previously, collagen, due primarily to its durability, is the sample material of choice for analysis of skeletal material. According to Schwarcz and Schoeninger (1991:293), there are three methods which can be utilized in the preparation of collagen for spectral analysis. Each method has its advantages and disadvantages and the method eventually used is researcher- and/or application-dependent. According to van der Merwe (1982:596), the precision of isotopic measures are generally in the range of ± 0.1 – 0.2‰ for all elements except hydrogen, the precision of which is ±1‰. The results of the analysis are reported relative to international standards: Pee Dee Belemnite (PDB) carbonate for carbon and oxygen and Ambient Inhalable Reservoir (AIR) for nitrogen. The results of the isotopic analysis can be reported in tabular form or as histograms, boxplots, or scatterplots.

Selected Maya Stable Isotope Studies

According to Wright *et al.* (2010:158), "In the Maya area, stable isotopic analysis has been most useful in examining the proportion of maize consumed, because maize is known to have been the only C4 plant that was consumed in significant quantities. Maize is distinguished from the abundant C3 plants in the Maya diet by its greater content of the stable isotope ^{13}C. … For the Maya, such studies have emphasized the analysis of bone collagen, which records a long-term average of food consumption." In the following sections we will examine a subset of the stable isotope studies conducted in the Maya area.

Copan (Whittington and Reed 1997)

The Whittington and Reed study was an investigation of skeletons "… from the low-status segment of Copan's population in order to learn about health and diet around the time of the collapse" (1997:157). Whittington conducted osteological analysis on 145 low-status skeletons while Reed conducted stable isotope analysis on 25 low-status skeletons, 57 elite skeletons, five deer, and one jaguar (Whittington and Reed 1997:158). Bone specimens for the analysis were taken from the ribs when possible or, failing that, "… several grams of miscellaneous bone fragments were removed from the skeleton" (Whittington and Reed 1997:159).

The study analysis shows that humans had a diet rich in C4 plants supplemented by small amounts of food from other sources (Whittington and Reed 1997:159). The most likely source of ^{13}C enrichment at Copan is maize. Analysis of the deer skeletons show that they were eating C3 plants and if humans had been eating the deer, the C3 plant signatures would have registered on the skeletons. While there is no statistically significant difference in the diet of the low- and high-status groups, the high-status individuals do exhibit a broader range of values. The interpretation is that the high-status individuals had access to a wider range of plant foods (Whittington and Reed 1997:160).

Copan (Price *et al.* 2010)

The authors review the early history of Copan and the burials excavated from under the Acropolis by the Copan Acropolis Archaeological Project and the Early Copan Acropolis Project as part of a study which uses stable isotope analysis to determine the origins of these now-dead individuals. In their discourse on K'inich Yax K'uk Mo', the authors say that the evidence (Mexican-style architecture, K'inich Yax K'uk Mo's Teotihuacan-style warrior garb) points to him having close ties with Tikal and Teotihuacan and accept without reservation Stuart's hypothesis of his birthplace as Caracol. They assert, however, that he left Caracol as a young man and grew up at court in Tikal from whence he launched his eventual conquest of Copan as an agent of Tikal.

The authors use oxygen, carbon, and strontium from tooth enamel to conduct stable isotope analysis designed to identify non-local individuals among the burials. The methodology consisted of taking samples from each of the remains and then comparing the stable isotope measures to known measures in Copan as well as the broader Maya area. Oxygen isotopes signal where an individual might have consumed water in their early years while strontium isotopes trace the geology of an area which is taken in through the food chain and embedded in the teeth during the formative years.

The results of the oxygen stable isotope, strontium stable isotope, and combined oxygen-strontium stable isotope analyses show that some of the skeletons were of non-local origin and that the remains of K'inich Yax K'uk Mo' probably had its origins in the central Peten. This confirms an earlier finding by Buikstra *et al.* (2004) The study findings could not pinpoint exactly where K'inich Yax K'uk Mo' was born.

Pan-Maya (Gerry 1997)

In Gerry's study of bone isotope ratios of Classic-period Maya, skeletal samples from seven Maya sites, including Copan, were subjected to stable isotope analysis to determine whether the Maya elite had dietary privileges when compared to other elements of the society. A total of 178 skeletons were analyzed with 65 deemed to be commoners, 39 junior elites, 39 petty elites, and 42 high elites (Gerry 1997:48). The author used a variety of analysis techniques to test for isotopic variation across time, sex, social status, and geographic location (Gerry 1997:56). The areas of interest for the purpose of this study are the variation across time, status, and space.

As regards variability through time, the author states thusly: "Dietary behavior during the early and late Classic periods appears to have been roughly equivalent (Gerry 1997:56)." The mean values for both $\delta^{13}C$ and $\delta^{15}N$ are remarkably similar for both periods (Gerry 1997:Table

III). As it relates to status, Gerry did find some variability. The data indicated commoner, high-elite, and petty/junior elite clusters but the author points out that "… while the mean δ values of these three status clusters are statistically distinct … there is a great deal of overlap between them at 1 standard deviation" (Gerry 1997:59). The isotopic data in the study tended to group together by region (Gerry 1997:Figure 9). The author argues that the more positive $\delta^{13}C$ values of the Peten group indicates the strongest maize signatures while the relatively low $\delta^{15}N$ values from Copan indicates a greater protein contribution from legumes than from meat (Gerry 1997:60).

Based on the foregoing data, the author concluded that "… dietary behavior among the Classic Maya was not so much socially dictated as it was geographically determined" (Gerry 1997:61-62). He posited that settlement patterns accounted for this regional variation with dense settlement patterns reducing the availability of animal species for human consumption (Gerry 1997:64). Copan, with a settlement density of 1449/km^2 provided a potentially hostile environment for game animals.

Pacibatun (White *et al*. 1993)

This study (White, Healy, and Schwarcz 1993) was aimed at determining whether status impacts could be detected in the diet of the Maya living at Pacibatun in Belize. Arguing that mortuary treatment was an indicator of status, the authors conducted stable isotope analysis on skeletons recovered from crypts/cists, pits, and urns. The authors found differences by grave type in $\delta^{13}C$ but not in $\delta^{15}N$ (White, Healey, and Schwarcz 1993:362) with 70% of the crypt/cist diet being C4 and, at the other end, 51% of the pit diet being C4.

Kaminaljuyu (Wright *et al*. 2010)

In this study, Wright *et al.* (2010) conducted stable isotope analysis of collagen sampled from dentine, enamel, and bone of skeletons from the tombs of Mounds A and B of Kaminaljuyu in order to determine place of origin (Wright *et al.* 2010:155). The study premise was that the range of carbon, nitrogen, oxygen, and strontium isotope analyses would indicate the level of interaction with central Mexico (Teotihuacan) and other Maya polities. The oxygen and strontium isotopes, in that they are laid down in the formative years and then are unchanged for the remainder of the individual's life, were expected to be the primary sources of information regarding place of origin.

Based on analysis of these data, the authors concluded that the centrally located skeletons were from individuals who had originated in Kaminaljuyu while the peripheral skeletons were not. This led to the hypothesis that these peripheral skeletons were sacrifices that had been interred simultaneously with the primary burials (Wright *et al.* 2010:174). The data showed that most of these "victims" came from the Lowland Maya regions, which led to the conclusions that (i) immigration from Teotihuacan to Kaminaljuyu was uncommon and (ii) any interaction between the two polities had been channeled through the latter's interaction with Lowland Maya polities (Wright *et al.* 2010:175).

<u>Caracol Stable Isotope Study (Chase and Chase 2001)</u>

In a publication on the royal tombs of Caracol, an ancient Maya ruin in the country of Belize, Chase and Chase (2001) reported on a stable isotope study that revealed what they termed a "palace diet" associated with the royal inhabitants. Chase and Chase (2001:103) define a Classic Period Maya palace as "an elite or royal dwelling place, usually constructed using stone walls and a vaulted roof … it probably also had administrative functions". In their work at Caracol, Chase and Chase (2001:107) have identified nine epicentral and 12 core palace compounds to include Caana, Structure B, Central Acropolis, South Acropolis, Barrio, and the epicentral C Group. Palace-compound interments are noted as having been both tomb- and non-tomb-burials with epicentral burials consisting of one to five individuals. Royal tombs self-identify in that they are generally the largest at the site and contain hieroglyphic text on the walls or capstone (Chase and Chase 2001:103)

The isotope analysis on bones recovered from royal tombs showed diets that were uniformly higher in both protein and maize than the diets of other segments of the population. In contrast to the palace diet, bones recovered from causeway termini groups and associated housing – conceptually elite housing – revealed high levels of protein consumption but lower levels of maize consumption. Analysis of skeletal material recovered from residential groups proximate to the epicentral areas indicated that these residents had the worst diets (Chase and Chase 2001:130). A number of skeletons deemed to be sacrificial offerings were recovered from the epicentral palaces and subjected to stable isotope analysis and their diets were found to be nonconforming to the aforementioned palace diet.

DATA

In order to develop the proposed stable isotope measures for K'inich Yax K'uk Mo', raw stable isotope data from Copan (his most recent home polity) and Caracol (his proposed point of origin) needs to be collected.

Caracol Stable Isotope Data

The skeletal data base used for the Caracol stable isotope analysis is presented as Appendix E (courtesy of A. Chase and D. Chase) and the associated graphical representation as Figure 2 (axes reversed and not labeled). Figure 3 illustrates the time depth of the Caracol stable isotope analysis data and also shows the application of conventional stable isotope labeling schemas in contrast to Figure 2.

The skeletons exhibiting "palace diet" characteristics are isolated in Table 4. These skeletons were isolated by comparing the lot numbers of the skeletons in Appendix E to the lot numbers of the overall Caracol skeletal data base shown in Table 10.1 of Chase (1994). The graphs of the mean and standard deviations of this sample are compared to the population as a whole in Figure 4. If Stuart (2007) is correct, and K'inich Yax K'uk Mo' did originate from Caracol, Figure 4 shows where stable isotope measures for palace dwellers and the broader population fell while he lived there.

Copan Stable Isotope Data

According to Whittington and Reed (1997:160) there is no statistically significant difference in the diet of Copan low- and high-status groups. In that most stable isotope data

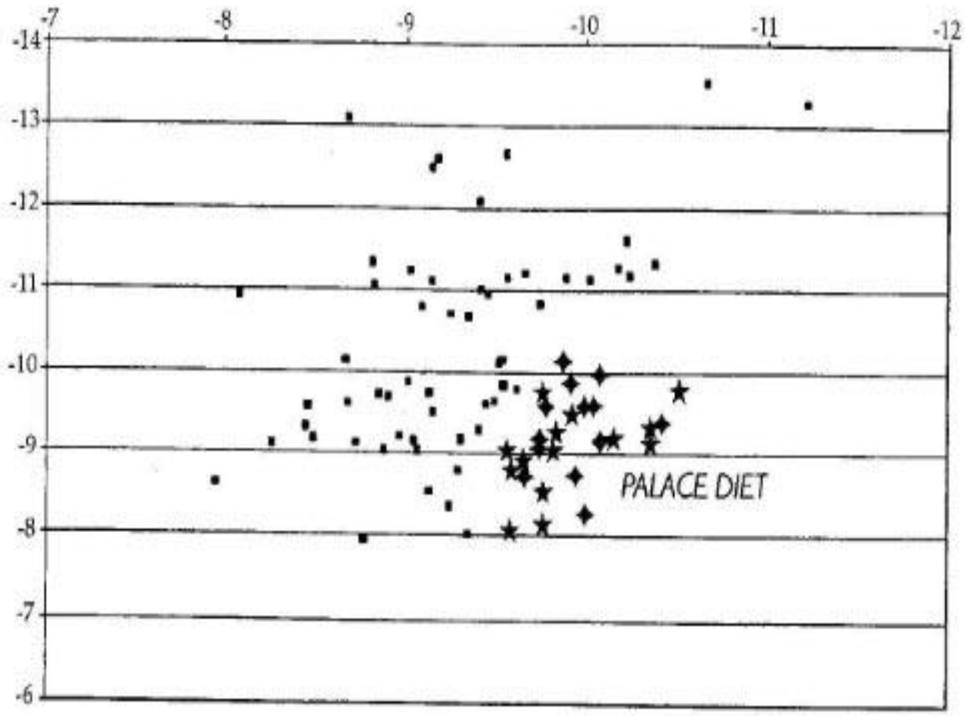

FIGURE 4.14 Caracol stable isotope data showing "palace diet." Higher levels of 15N Collagen indicates the consumption of more protein. Lower levels of 13C Collagen indicates higher levels of maize consumption. "★" indicate individuals in epicentral tombs, including those associated with palace compounds. "✦" indicate individuals with a "palace diet" who are not buried in palace compounds. "■" indicate other Caracol burials that were sampled.

Figure 2. Graphical illustration of Caracol stable isotope analysis (Chase and Chase 2001:129)

are gleaned from Late Classic skeletons, it is important to have a vehicle whereby Late Classic stable isotope data can be adjusted to reflect the Early Classic period. Thankfully, no such vehicle is required for the Maya as Gerry (1997:56) has found that "Dietary behavior during the

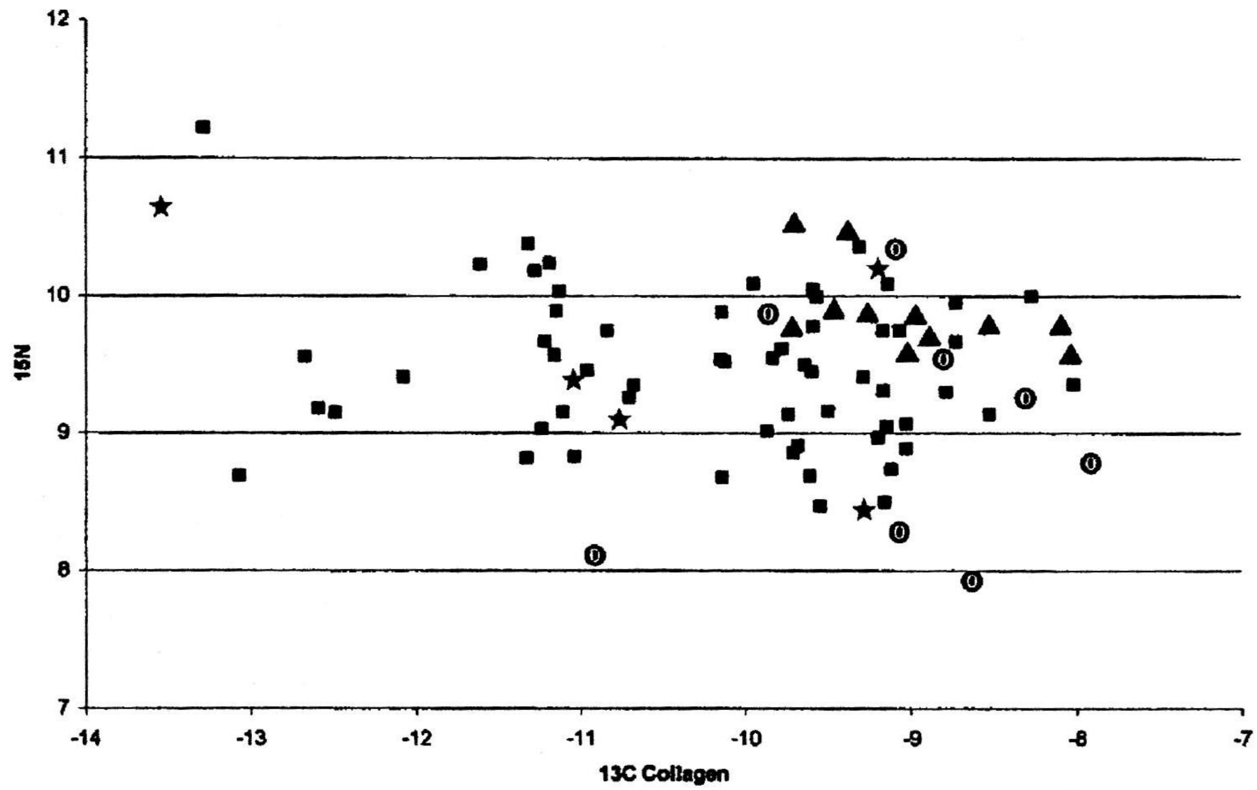

FIG. 5.—Valores de isótopos estables de C13 comparados con 15 de Caracol: los cuadros representan el Clásico Tardío; los círculos el Clásico Temprano; las estrellas el Clásico Terminal; los triángulos representan todos los individuos dentro de tumbas del Clásico Tardío en el epicentro de Caracol.

Figure 3. Time depth of Caracol stable isotope data (Chase, Chase, and White 2001:113) where squares = Late Classic, Circles = Early Classic, stars = Terminal Classic, and triangles = Late Classic

early and late Classic periods appears to have been roughly equivalent." The Copan stable isotope measures coming out of the Gerry (1997) study were -10.2 $\pm$ 0.92 ($\delta^{13}C$) and 7.6 $\pm$ 0.78 ($\delta^{15}N$).

Table 4. Palace residents whose remains were recovered from epicentral contexts

Lot #s	Compound	Structure	$\delta^{13}C$	$\delta^{15}N$
C1B/6-3	Caana	B20	-9	9.66
C4C/21-9	Caana	B19	-9.75	9.77
C86C/19-1 (South)	Caana	A38	-8.06	9.59
C86C/19-1 (N. West)	Central Acropolis	A38	-8.54	9.77
C87E/12-1 (indiv.2)	Central Acropolis	A34	-8.12	9.77
C87E/12-1 (indiv.3)	Central Acropolis	A34	-9.24	9.84
C87E/12-1 (indiv.1)	Central Acropolis	A34	-9.35	10.43
C88C/14-75	South Acropolis	D16	-8.8	9.59
N=8				
Mean		-8.857	9.802	
Std. Dev.		0.596	0.269	

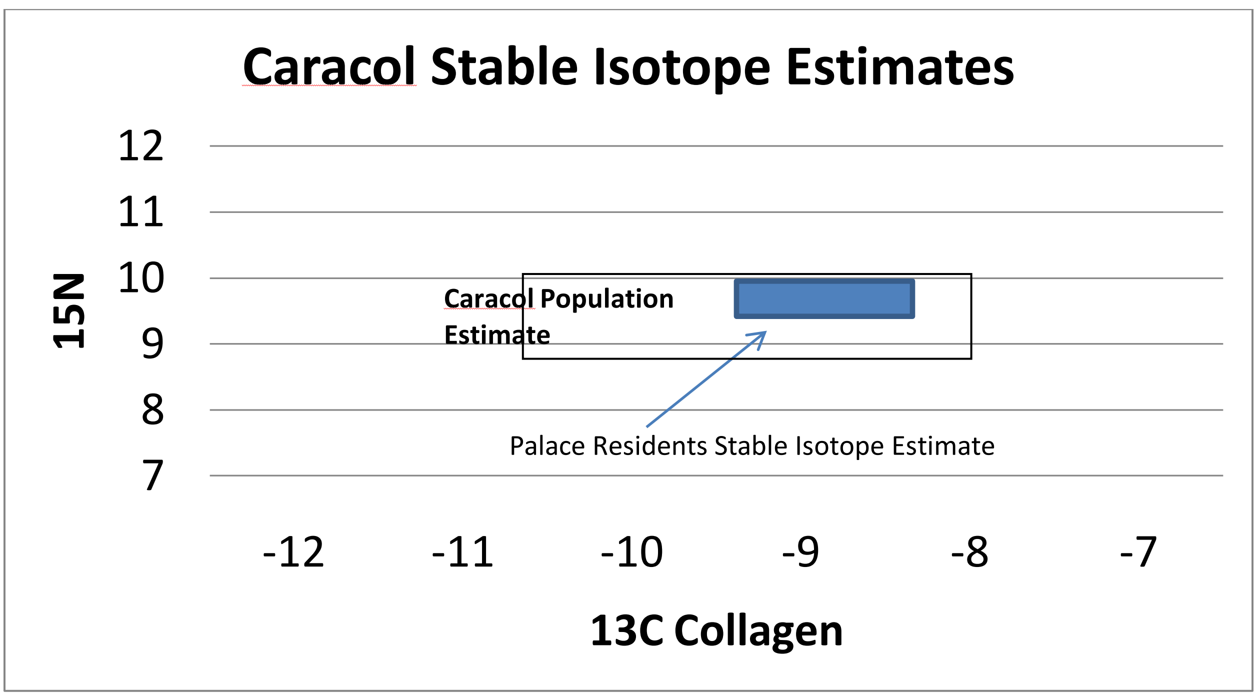

Figure 4. Caracol population and Palace residents stable isotope maps.

DERIVATION OF K'INICH YAX K'UK MO's STABLE ISOTOPE MEASURES

Assumptions

This thesis set out to show that stable isotope analysis could be used to predict K'inich Yax K'uk Mo's stable isotope measures based on Stuart's (2007) hypothesis that K'inich Yax K'uk Mo', the dynastic founder of the Copan royal lineage, was a Caracol lord. A number of assumptions underpin this thesis: (i) K'inich Yax K'uk Mo' had his origins outside of Copan; (ii) his place of origin was Caracol; (iii) he came directly from Caracol to Copan; (iv) he lived in Copan for at least 10 years; (v) there is a "Palace diet" phenomena at Caracol; (vi) K'inich Yax K'uk Mo' partook of that diet while in Caracol; and (vii) the remains excavated at Hunal are in fact K'inich Yax K'uk Mo's.

(i) Non-Copanec origin for K'inich Yax K'uk Mo'. There is significant and convincing evidence that K'inich Yak K'uk Mo' had a non-Copanec origin. First, according to the accession story detailed on Altar Q, he took the God-K scepter of royal authority on September 5, AD 426 and three days later he "arrived" at the "Foundation House" as the founder of the lineage (Fash 2001:79; Harris 1999:23; Marcus 2003:94;Martin and Grube 2000:192-193; Schele and Friedel 1990). These events occurred at a location other than Copan because 152 days elapsed before he finally arrived at the city (Marcus 2003:95; Martin and Grube 2000: 192-193). According to Harris (1999:23), the God-K scepter was received at a place called Ch'okte Na and this event, as well as K'inich Yax K'uk Mo's arrival at the "Foundation House" three days later, is recorded on Zoomorph 7 at Quirigua. Second, an analysis by Buikstra *et al.* (2004) of the skeleton found in the Hunal tomb – a skeleton that is thought to be the final remains of K'inich Yax K'uk Mo'

(Sharer *et al.* 1999:7) -- found that the person in the tomb had not spent his youth in Copan but was, instead, from the central Maya lowlands. Third, architectural change as a result of K'inich Yax K'uk Mo's accession to the Copan throne is very evident in the archaeological record. Prior to K'inich Yak K'uk Mo's arrival at Copan, the architecture reflected southeastern traditions but after his installation a number of lowland Maya elements begin to intrude. According to Marcus (2003:96), "K'inich Yax K'uk Mo' evidently brought the template of a powerful preexisting state with him and established a grand architectural plan that was maintained throughout the history of the Copan Acropolis."

(ii) His place of origin was Caracol. Over the years, Mayan scholars have wrestled with the role that Teotihuacan played in the development of the Maya socio-cultural environment. Arguments have ranged from conquering central Mexicans to Teotihuacanos as merchants with merchant outposts to "internalist" views where Mayan leaders appropriated Teotihuacan ideology, iconography, and trade goods to create societal status distance and/or legitimization schemas (Braswell 2003; Stuart 1998). Epigraphic data have historically pointed to Tikal and Kaminaljuyu as being the most significant centers of Teotihuacan influence (Braswell 2003:3). Some scholars argued for a Copan-Teotihuacan link passing through one of these two polities. His installation and reign provided extensive evidence of interaction with Teotihuacan, probably through an intermediary such as Tikal or Kaminaljuyu (Fash and Stuart 1991:154: Sharer 2004:300). "The preponderance of slab-footed tripod vessels, polished blackwares, and incised vessels bespeaks intensive and sustained commercial interaction with the highlands ..." (Fash and Stuart 1991:154). Sharer (2003:150) points out that a number of items recovered from the Hunal tomb can be tied back to Teotihuacan or the Teotihuacan warrior figures on the side of Tikal

Stela 31. Sharer further asserts that Teotihuacan had links with Tikal prior to the Copan founding and, therefore, it is not unlikely that if K'unich Yax K'uk Mo' came from Tikal that he would bring along advisers and paraphernalia which reflected the Teotihuacan influence (Sharer 2004:300). The author sees the contemporary founding of Quirigua as an attempt by Tikal to control the Motagua obsidian and jade trade and exerting influence on Copan would allow Tikal "... better access to the markets and resources of Central America" (Sharer 2004:300). Skidmore (ND) concludes that "All of the evidence together suggests that the founder of Copan was part of the Teotihuacan incursion into the polities of the Maya realm."

It was into this prevailing sentiment that Stuart (2007) advanced his hypothesis that K'inich Yax K'uk Mo' was a Caracol lord prior to coming to Copan as the founding dynast. Price *et al*. (2010:23) see Stuart's "conclusion" that K'inich Yax K'uk Mo' originated in Caracol as justified but do not offer additional supporting arguments. The authors point out the lack of supporting archaeological material that links founding period Copan to Caracol (Price *et al.* 2010:21); rather, the available archeology links K'inich Yax K'uk Mo' to Tikal (Price *et al.* 2010:21). The authors exploit this connundrum by proposing that K'inich Yax K'uk Mo' was born a Caracol Lord but moved to the royal palaces in Tikal at a young age and launched his takeover of Copan as an agent of Tikal (Price *et al* 2010:21).

Recent work by Chase and Chase (In Press) calls the Price *et al*. position into question. In the 2010 field season of the Caracol Archaeological Project (CAP), the team recovered Special Deposit C117F-1 from deep below the Northeast Acropolis (Chase and Chase In Press:10). The deposit, which included burnt and shattered bones of three individuals, was retrieved from "a square pit with rounded corners" which itself showed evidence of burning at high heat (Chase and Chase In Press:9-10). In addition to the remains, a number of artifacts, many showing evidence of violent shattering, were recovered. It is estimated that the deposit dates to between A.D. 250 and A.D. 350 (Chase and Chase In Press:9). The typology of the artifacts in the deposit, the size and construction of the burial pit, and the characteristics of the cremation led the authors to conclude that (i) the burial practices associated with the deposit were Teotihuacan-like and (ii) at least one of the of the interred individual had been of high status. The authors further note that the date of the deposit overlaps the founding of the Caracol dynasty and may in some way be associated with that event (Chase and Chase In Press:15).

Due to factors such as his shield bearing the image of the war serpent of Teotihuacan, his depiction with the Teotihuacan cut-shell goggles, and the square shield on his right hand in the Altar Q depiction (Skidmore ND), K'inich Yax K'uk Mo' has always been associated with Teotihuacan. Some scholars have channeled this Teotihuacan influence through Tikal (Fash and Stuart 1991:154; Price *et al*. 2010:21; Sharer 2004:350) or Kaminaljuyu (Fash and Stuart 1991:154; Sharer 2004:350). Stuart (2007) hypothesized that K'inich Yax K'uk Mo' originated in Caracol and the work of Chase and Chase (In Press) gives additional credence to this hypothesis. K'inich Yax K'uk Mo's Teotihuacan affiliation (Skidmore ND; Sharer 2003), coupled with (i) his Caracol-related nomenclature on Copan Stela 63 and (ii) the evidence of a Teotihuacan presence at Caracol prior to the acknowledged presence of Teotihuacan at Tikal makes a strong case in support of Stuart's (2007) hypothesis.

(iii) He came directly from Caracol to Copan. This assumption is important in that it allowed the collection of data relevant to the study. Price *et al*. (2010:23) support a Caracol origin for K'inich Yax K'uk Mo' but see the available archaeological evidence as suggesting a

role for Tikal. In order to align this supposed data with the Stuart hypothesis, the authors propose a solution wherein K'inich Yax K'uk Mo' is born in Caracol, raised in a royal setting in Tikal, and is then dispatched by his Tikal overlords to conquer Copan (Price *et al*. 2010:21). In light of the Chase and Chase (In Press) work, such contortions are no longer necessary. The archaeological evidence clearly point to a relationship between Caracol and Teotihuacan that predates the Teotihuacan dynasty in Tikal by 50 years or more and so K'inich Yax K'uk Mo's Teotihuacan affiliations do not have to be tortuously band-aided on to him by passage through a surrogate polity. He would have been directly exposed to Teotihuacan imagery and practices in his homeland of Caracol.

(iv) *He lived in Copan for at least 10 years*. The earliest date associated with K'inich Yax K'uk Mo' is a retrospective mention of the date 8.19.0.0.0 (February 1, AD 426) on Stela 15, a monument of Waterlily Jaguar, the 7th dynastic ruler (Schele and Friedel 1990:311). The next, and most detailed, mention is on Altar Q, a monument of Yax-Pac, the 16th ruler in the dynasty. The front of the altar has a picture of K'inich Yax K'uk Mo' handing the insignia of authority to Yax-Pac with all of the intervening kings occupying positions around the remainder of the altar in order of their rule. On the top of the altar, Yax-Pac recorded that on September 5, AD 426, he took the God-K scepter of royal authority and three days later he "arrived" at the "Foundation House" as the founder of the lineage (Fash 2001:79; Martin and Grube 2000:192-193; Schele and Friedel 1990:311).

The earliest contemporary reference to K'inich Yax K'uk Mo' is found on Stela 63, a monument recovered by the ECAP program. The initial series date is 9.0.0.0.0 (AD 435) and the monument records "the display of the Manikin scepter" by Yax K'uk Mo' (Fash and Stuart

1991:151). Ruler 2, the son of K'inich Yax K'uk Mo', initiated a number of projects aimed at venerating his father's memory. The Xucpi Stone was "... a carved monolith found reset in the wall of an elaborate Early Classic royal tomb in the MAS complex" (Sharer et al 1999:10). The stone is believed by scholars to have been initially created for the tomb of Yax K'uk Mo' and set in the Yehnal structure for that purpose. The text on the Xucpi Stone indicated that it had been dedicated by Ruler 2 on November 30, 437 AD, in honor of his father. Based on the dedication date, scholars assume that Yax K'uk Mo' died in 437 AD. Based on his reported accession date and inferred death date, it seems safe to assume that K'inich Yax K'uk lived in Copan for a period exceeding 10 years.

(v) There is a Caracol Palace-diet phenomenon. See Figure 4.

(vi) K'inich Yax K'uk Mo' partook of the Palace diet while resident at Caracol. This assumption has to be considered as reasonable given the conditions and circumstances. First, Chase and Chase (2001) identified the Palace-diet phenomenon at Caracol and this author validated that finding in this study. Stuart (2007) hypothesized that K'inich Yax K;uk Mo' was a Caracol lord and this author proposes that if he was important enough to be sent off to secure Copan, he most likely lived within the Caracol Palace environment and participated in all Palace activities.

(vii) The remains recovered at Hunal are actually K'inich Yax K'uk Mo's. The archaeologists at Copan found the skeleton of an adult male between the ages of 50 and 70 years old and a rich assortment of grave goods in a vaulted tomb which was intruded into the substructure of the structure designated as Hunal (Sharer *et al.* 1999:7). Sharer (1997:31) posits that the tomb served as residence during its time and given its location in the newly minted royal

complex probably was the residence of the founder. Sharer goes on to remark on the orientation of Hunal (north) and the orientation of the structures built over Hunal (west) and concludes that "The attributes of all these successors … indicate that they were shrines dedicated to the veneration of the dynastic founder" (1997:32). The contents also point to the remains being K'inich Yax K'uk Mo's: the ceramics included in the grave date to the period of the founding of the Copan dynasty; a large jade pectoral found in the tomb is similar in appearance to the one he is pictured wearing on Altar Q; and the mat design found on a carved jade bead is the symbol for rulership (Bell *et al*. 2004; Sharer *et al* 1999:7, 2003:151). In addition, the small shield that he is wearing on his right hand on the portrait on Altar Q is consistent with the right-forearm parry fracture discovered by the Buikstra *et al* (2004) study (Sharer 2003:151).

Stable Isotope Measures Calculation

Stable isotope analysis has been utilized by the archaeological community to study a wide range of ancient activities (Table 3). In a preceding section I have summarized selected Maya stable isotope studies to show two of the major themes: (i) identification of status differentials and (ii) migration studies. In the Price *et al.* (2010) study, an attempt was made to identify the geographic origin of K'inich Yax K'uk Mo' using oxygen and strontium stable isotope analysis, but no additional findings beyond the original Buikstra *et al.* (2010) study was forthcoming.

Two of the studies presented were nitrogen and carbon stable isotope analyses for Copan and Caracol. This is relevant because (i) these cities are both associated with K'inich Yax K'uk Mo' -- the former because he ruled there and the latter because of Stuart's assertion – and (ii) the same isotopes are studied. In both studies, stable isotope analysis has been used to determine the dietary patterns of the inhabitants. In the Copan case, the analysis indicated no dietary differences based on status. The opposite is shown in the case of Caracol where Chase and Chase (2001) have identified what they call a palace diet in the remains of persons who either lived in the epicentral palaces or, at a minimum, ate palace food.

Figure 5 is a graphical illustration of the Copan and Caracol diets based on the results of the two stable isotope studies. The figure shows that, overall, the Caracol Maya had access to a wider array of plant foods than did the Copanec Maya and, in addition, their diet was richer in protein. The so-called palace diet exhibits a narrower range of plant consumption *vis a vis* both the broader Caracol sample and the Copan sample. The palace diet does show higher protein consumption than does the Copan sample but a lower overall protein consumption rate than for the Caracol sample as a whole. The significant implication of the Caracol study is the difference between the broader sample and the palace dieters.

This has clear relevance to the argument promulgated herein. We have clearly shown that K'inich Yax K'uk Mo' was of a non-Copanec origin. Stuart (2007) asserts that he was a Caracol lord and it follows, I posit, that he would have had to have been a high-ranking lord in Caracol to be sent out on a mission to subdue Copan. I further posit that as a high-ranking lord, he would have lived in the epicentral palaces and been sustained by a palace diet.

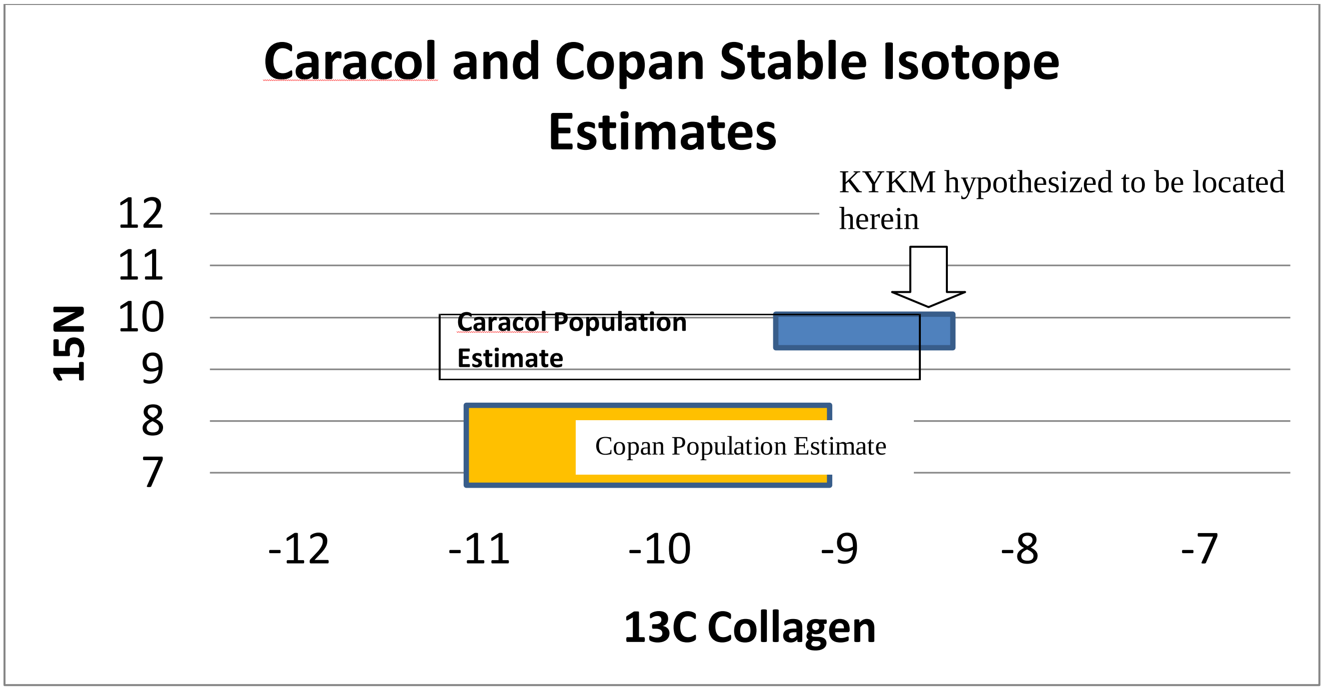

Figure 5. Caracol and Copan stable isotope maps.

Following this line of reasoning, then, if Stuart (2007) is correct, and K'inich Yax K'uk Mo' did originate from Caracol, his dietary signature would have fallen somewhere within the blue rectangle in Figure 5. To the best of our knowledge, he ruled at Copan for 10 or 11 years and research has shown that the collagen turnover rate is approximately 10 years (Schwarcz and Schoeninger 1991:285); therefore, his collagen signature at death would not have been the same as when he started out from Caracol. Further, there are two collagen signatures that we have to be concerned with: non-femoral-midshaft collagen (10-year turnover); and femoral midshaft collagen (turnover rates higher during adolescent years; e.g., Hedges *et al.* 2007).

The collagen turnover rate is approximately 10 years (Schwarcz and Schoeninger 1991:285), but more recent research (Hedges *et al.* 2007) has shown that collagen turnover in the femoral midshaft is higher during adolescent years than later in life. According to the authors, "… for turnover rates of 2%/year after age 25, even at age 50 years there is a 40% representation of collagen synthesized at age less than 25 years" (Hedges *et al.* 2007:815). Based on the foregoing, K'inich Yax K'uk Mo' would have two definable collagen signatures at death (non-femoral midshaft and femoral midshaft) and it is the occurrence of a definable range in these two signatures which would indicate a likelihood that he did in fact originate from Caracol. Non-Femoral midshaft collagen turnover can be represented by the following equation:

$$Collagen_{new} = (1/10Target_{coll} – 1/10Source_{coll})X + Source_{coll}, \quad (3)$$

where,

$Collagen_{new}$ is the collagen metric at a specific point in time,
$Target_{coll}$ is the collagen metric of the target population,
$Source_{coll}$ is the collagen measure of the original population, and
X is the number of years since the individual has been consuming the new diet.

The overarching assumption is that the equation becomes moot after 10 years because we can make the assumption that there has been full collagen turnover after 10 years. The corresponding femoral midshaft turnover equation is:

For $25 \geq X < 80$,

$$Collagen_{new} = (.02Target_{coll} – .02Source_{coll})X + Source_{coll}, \quad (4)$$

where,

$Collagen_{new}$ is the collagen metric at a specific point in time,
$Target_{coll}$ is the collagen metric of the target population,
$Source_{coll}$ is the collagen measure of the original population, and
X is the number of years since the individual has been consuming the new diet.

Having ruled in Copan for in excess of 10 years, all of K'inich Yax K'uk Mo's non-femoral midshaft collagen would have turned over and his stable isotope signature would be as broad as the Copan population shown in Figure 4. In the case of femoral midshaft collagen, however, less than 20% of his collagen would reflect the Copanec diet. Applying these parameters, K'inich Yax K'uk Mo's stable isotope measures would be as indicated in Table 5 and Figure 6.

Table 5. Estimate of K'inich Yax K'uk Mo's Stable Isotope Measures at Death (Assuming a Caracol Origin)

Collagen Type	$\delta^{13}C$	Std. Dev.	$\delta^{15}N$	Std. Dev
Non-Femoral midshaft	-10.2	0.92	7.6	0.78
Femoral midshaft	-9.13	0.596	9.36	0.269

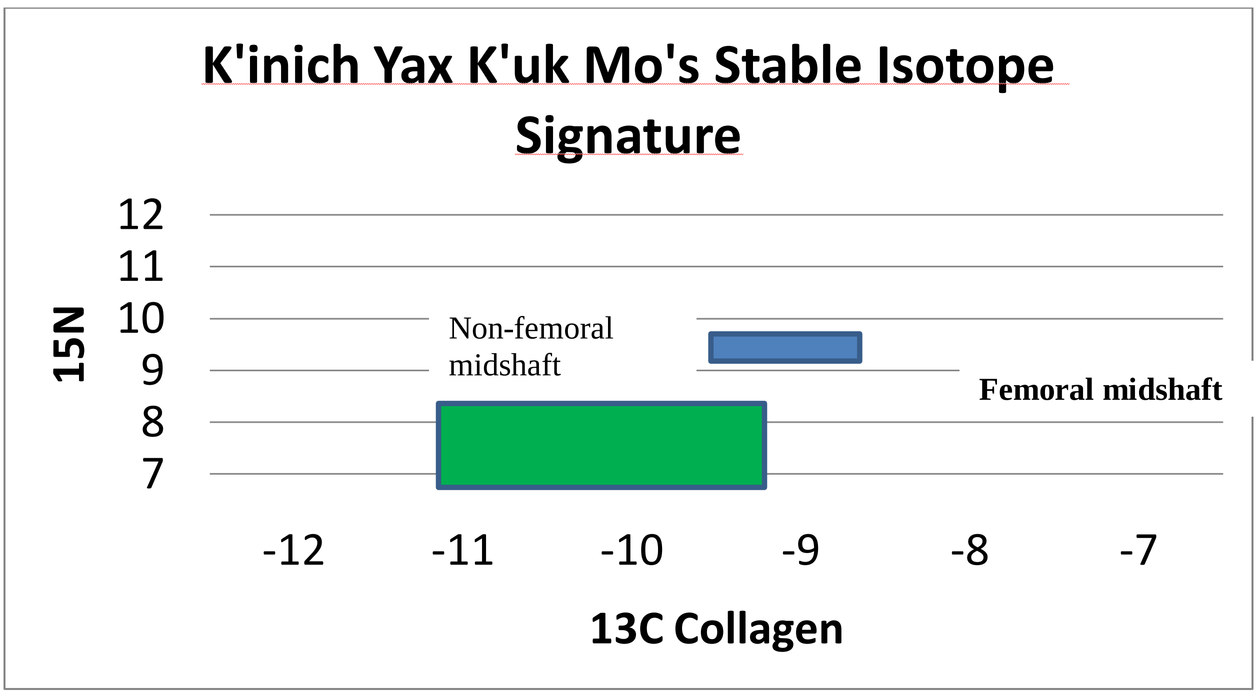

Figure 6. K'inich Yax Ku'k Mo's stable isotope signature

CONCLUSIONS

At its core, the story of K'inich Yax K'uk Mo's ascension to the Copan throne is a migration tale. Regardless of his actual polity of origin, he arrived at Copan as the founding dynast in A.D. 426 and, by his architectural direction, set Copan on its course as one of the most refined and cultured of the Maya kingdoms. But we have more than passing clues as to K'inich Yax K'uk Mo's origin. Stuart (2007) has identified Caracol as his polity of origin and has been supported in that position by Price *et al*. (2010). Recent work by Chase and Chase (In Press) lend further credence to the Caracol-origin hypothesis in that it reveals a Teotihuacan presence in Caracol prior to the founding of the Teotihuacan-linked Tikal dynasty, a dynasty and polity which had been deemed a possible origin site for K'inich Yax K'uk Mo'. The revelation of a Teotihuacan presence in Caracol suggests that K'inich Yax K'uk Mo' seized the mantle of Teotihuacan , as did the migrant kings at Tikal (Stuart 1998) and, possibly, Caracol (Chase and Chase In Press), and utilized the imagery, religion, and architecture of that great city to dazzle his new subjects with an atypical claim on legitimacy to rule.

Stable isotope analysis has been utilized in the study of a variety of paleodiet and migration issues, as illustrated broadly in Table 3 and, specifically, in the studies summarized herein. With reference to migration studies, analyses of the stable isotopes of oxygen and strontium in tooth enamel has been the preferred approach because teeth retain the isotope signature of regional groundwater consumed in the early years of growth. An effort to produce Maya-region-wide oxygen and strontium isotope maps is underway but is as yet incomplete. The use of oxygen and strontium has, to date, been used to rule out some areas (Copan, for example) as points of origin for K'inich Yax K'uk Mo' and give broad approximations (Peten) of the answer. The current study is the first to use the stable isotopes of carbon and nitrogen to predict the stable isotope measures of an individual. In that the evidence points to Caracol as the original home of K'inich Yax K'uk Mo', the results of this methodology could potentially be used as a validation screen for the remains recovered from Hunal and purported to be those of K'inich Yax K'uk Mo'.

APPENDIX A: DR DAVID STUART

Dr. David Stuart is currently the Linda and David Schele Professor of Mesoamerican Art and Writing at the University of Texas at Austin (UTAustin), a position which he has held since 2004. In addition, Dr. Stuart is the Director of the Mesoamerican Center, an organization at UTAustin which "… fosters multi-disciplinary studies and produces publications on ancient American Art and Culture" (Department of Art and Art History, UTAustin; Take 5). Dr. Stuart, who gained his doctoral degree from Vanderbilt University in 1995, taught at Harvard for 11 years prior to his appointment at UTAustin. Dr. Stuart has authored/co-authored several books and articles including the seminal Ten Phonetic Syllables (Stuart 1987) which "… laid much of the groundwork for the now-accepted methodology of decipherment" (Department of Art and Art History, UTAustin) and Palenque: Eternal City of Light (Stuart and Stuart 2008) which he co-authored with his father. Michael Coe (Coe 1999) has described Dr. Stuart as one of "… a small handful of truly brilliant epigraphers …" while William Fash, the William and Muriel Seabury Howells Director of the Peabody Museum and the Charles P. Bowditch Professor of Central American Archaeology and Ethnology at Harvard University, refers to Dr. Stuart as "… one of the masters who is on the cutting edge of his field" (The Harvard Lamplighter).

APPENDIX B: CHARACTERISTICS OF BONE AND COLLAGEN

Characteristics of Bone

- Complex tissue composed of:
  - Water
  - Organic matrix (90% collagen, 5% noncollagenous protein, 5% lipids and carbohydrates
  - Inorganic mineral fraction closely bound to the organic matrix (55-75% of dry weight)
- Carbon/nitrogen-containing components are useful for human dietary studies

Components	Carbon	Nitrogen
Collagen	X	X
Noncollagenous proteins	X	X
Carbohydrates	X	
Lipid proteins	X	

Source: Compiled from Schwarcz and Schoeninger 1991:296.

Characteristics of Collagen

- Fibrous protein constituting approximately 25% of all proteins occurring in mammals
- Type 1 properties:
  - Found in bone, skin, dentine, and tendon
  - Great tensile strength
  - relative insolubility due to extensive linkages between each of its three equal-sized chains
    - Each chain is approximately 300 nanometers in length and contains 1000 amino acid residues
      - 1/3 of residues are glycine
      - 1/5 to ¼ comprised of proline and hydroxyproline
    - regular glycine X-Y sequence accounts for collagen's structural integrity and triple helical form
- The low C-N ratio and large relative amount of glycine plus proline/hydroxyproline are considered diagnostic features of collagen

Source: Compiled from Schwarcz and Schoeninger 1991:292.

APPENDIX C: TRANSFERRING NITROGEN INTO THE BIOLOGICAL REALM

Process	Characteristics
Nitrogen-Fixing organisms	● Bluegreen algae in acqueos solution or bacterial nodules on terrestrial plant roots ○ Inefficient process – results in synthesized tissues with δ15N values similar to atmospheric N2
Bacterial action following the death of an organism	● Complex nitrogen-containing molecules in organic matter broken down in this fashion ● Nitrification and denitirfication produces and decomposes nitrates that can be used directly by vascular plants ● δ15N values of these nitrates are more positive than the atmosphere

Source: Compiled from Schwarcz and Schoeninger 1991:304.

APPENDIX D: CHARACTERISTICS OF THE PHOTOSYNTHETIC PATHWAYS

Pathway	Characteristics
C3	• Enzyme ribulose biphosphate carboxylase to fix atmospheric CO_2 • Three carbon atoms present in earliest post-fixation metabolites • δ13C values between -33 and -22‰; average of -27‰ • Cultivated and wild plants in temperate regions
C4	• Enzyme phosphoenal pyruvate carboxylase for fixation of atmospheric CO_2 • Four carbon atoms appear in earliest post-fixation metabolites • δ13C values between -16 to -9‰; average of -12.5‰ • Maize, millet, sorghum; many C4 grasses found in areas of low rainfall
CAM	• Utilizes both C3 and C4 pathways; selection based on environmental considerations

Source: Compiled from Schwarcz and Schoeninger 1991:303; van der Merwe 1982:596-597; DeNiro 1987:183.

APPENDIX E: SKELETAL DATA BASE USED FOR CARACOL STABLE ISOTOPE ANALYSIS

Lot#		$\delta^{13}C$	$\delta^{15}N$
C01B/06-3		-8.9	9.66
C03C/05-1		-11.24	9.03
C03C/05-1	INDV 2	-10.14	8.68
C04C/21-9		-9.75	9.77
C05B/01-7		-9.59	10.05
C06B/16-2		-10.96	9.46
C06B/16-2	INDIV A	-11.16	9.57
C06B/27-3		-9.31	10.36
C06B/30-1		-11.19	10.24
C07B/12-1	WALL	-13.28	11.22
C07B/12-1	SAMP 1	-13.07	8.69
C07B/12-1	SAMP 4	-12.08	9.41
C07B/16-1		-12.67	9.56
C08S/04-1		-9.3	8.46
C12A/72-10		-9.76	10.52
C14A/05-7		-8.03	9.35
C14A/12-06		-10.8	9.1
C14C/10-27	SAMP 1	-10.68	9.35
C14C/10-27	SAMP 2	-9.17	9.31
C14C/13-6		-8.35	9.25
C14C/14-2		-9.59	9.78
C14D/01-5		-9.6	9.45
C14E/10-16		-9.64	9.5
C15A/06-3		-9.07	9.75
C18U/23-3		-9.18	10.16
C19A/28-8		-9.03	9.57
C19A/32-3		-8.73	9.95
C19A/32-3	S	-10.12	9.52
C19A/39-3		-9.87	9.02
C22A/28-11		-11.28	10.18
C22A/32-3		-11.04	8.83
C22E/38-17		-11.11	9.15
C22E/38-17	INDIV 2	-11.22	9.67
C22E/38-17	INDIV 3	-11.15	9.89
C22E/38-17	INDIV 5	-9.17	9.75
C24B/03-1		-9.68	8.91
C24B/05-8		-9.2	8.97

C24C/03-36		-9.16	8.5
C28A/04-9		-8.79	9.3
C28A/06-7		-9.03	8.89
C29A/07-7		-9.57	10
C31A/03		-8.73	9.67
C31A/05-3		-9.29	9.41
C32B/05-25		-9.03	9.07
C32B/05-25	INDIV 1	-11.33	8.82
C35A/9-13		-11.61	10.23
C36A/02-26		-9.14	10.09
C39B/04-5		-9.83	9.55
C39B/10-15	#1	-10.15	9.54
C39E/17-2		-11.13	10.03
C39E/28-4		-11.32	10.38
C39E/34-12	FLOOR	-7.95	8.78
C39E/34-12	INDV 1	-8.35	9.25
C39E/38-4		-9.71	8.86
C39E/40-8		-9.95	10.09
C49A/05-5		-9.78	9.62
C49A/06-8		-9.5	9.16
C49A/08-9		-9.55	8.47
C49A/09-8		-10.71	9.26
C49A/12-2		-9.86	9.92
C50A/07-5		-9.12	8.74
C59A/30-34	5 INDIV	-8.53	9.14
C60B/08-1		-9.09	8.28
C60B/09-7	INDV 2	-10.93	8.09
C60B/09-7	INDV 5	-8.64	7.96
C66B/11-8	#2	-12.49	9.15
C66B/11-8	#3	-12.59	9.18
C71E/27-1		-13.53	10.66
C73B/40-10	SE BENCH	-9.02	9.83
C73B/40-10	SAMP 2	-9.49	9.93
C74B/3-14		-11.01	9.42
C79B/18-3		-9.14	10.09
C79B/35-1		-9.15	9.05
C85C/18-3		-10.14	9.88
C85C/21-17		-9.74	9.14
C85C/21-17	INDIV 2	-9.61	8.69

C86C/15-1			-10.84	9.75
C86C/19-1	S		-8.06	9.59
C86C/19-1	NW		-8.54	9.77
C87E/12-11	INDV 2		-8.12	9.77
C87E/12-11	INDV 3		-9.24	9.84
C87E/12-11	INDV 1		-9.35	10.43
C88C/14-75			-8.8	9.59
C88C/14-75			-9.11	10.36
C14A/06-07			-8.27	10.01
		Mean	-9.93094	9.486118
		Std Dev	1.266873	0.604631

Courtesy of A. Chase and D. Chase; processed by C. White and F. Longstaffe.
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April 29, 2011

Dr. Arlen F. Chase
Pegasus Professor and Chair, Department of Anthropology, College of Sciences
University of Central Florida
Orlando, FL 32816

Dear Dr. Chase:

This letter will confirm our recent email communication. As my Thesis Committee Chair, you are aware that I am currently pursuing a master's degree at the University of Central Florida entitled "A Methodology to Predict the Carbon and Nitrogen Stable Isotope Measures of K'inich Yax K'uk Mo', Copan Dynastic Founder." I would like your permission to re-print in my thesis excerpts from the following:

Chase, Arlen F., Diane Z. Chase, and Christine White, 2001, "El Paisaje Urbano Maya: La Integracion de los Espacios Construidos y la Estructura Social en Caracol, Belice," in A. Ciudad Ruiz, Ed., La Ciudad Antigua: Espacios, Conjuntos e Integracion Sociocultural en la Civilizacion Maya, pp. 95-122, Sociedad Espanola de Estudois Mayas, Madrid.

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