Scarlet Macaws, Long-Distance Exchange, and Placemaking in the U.S. Southwest and Mexican Northwest, ca. 900-1450 CE

by

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ABSTRACT

Exchange is fundamental to the establishment and maintenance of social institutions and political economies in all scales of societies. While today people rapidly exchange goods and information over great distances, in the past, long-distance exchange necessitated the mobilization of vast networks of interaction with substantial transport costs. Objects traded over long distances were often valuable and challenging to obtain, granting them multifaceted significance that is difficult to understand using traditional archaeological approaches.

This research examines human interactions with scarlet macaws (*Ara macao*) in the United States (U.S.) Southwest and Mexican Northwest (SW/NW) between 900 and 1450 CE. This period saw large-scale cultural change in the form of migrations, rapid population aggregation, and an expansion of long-distance exchange relations in regional centers at Pueblo Bonito (900-1150 CE) in northwestern New Mexico, Wupatki (1080-1220 CE) in north-central Arizona, and Paquimé (1200-1450 CE) in northern Chihuahua. Despite the distant natural habitat of scarlet macaws, their importation, exchange, and sacrifice appear to have played integral roles in the process of placemaking at these three regional centers. Here, I use an Archaeology of the Human Experience approach and combine radiogenic strontium isotope analysis with detailed contextual analyses using a Material Histories theoretical framework to (1) discern whether macaws discovered in the SW/NW were imported or raised locally, (2) characterize the acquisition, treatment and deposition of macaws at Pueblo Bonito, Wupatki, and Paquimé, and (3) identify patterns of continuity or change in acquisition and deposition of macaws over time and across space in the SW/NW.

Findings from radiogenic strontium isotope analysis indicate that scarlet macaws from all case studies were primarily raised locally in the SW/NW, though at Paquimé, macaws were procured from sites in the Casas Grandes region and extra-regionally. Variation in the treatment and deposition of scarlet macaws suggests that despite their prevalence, macaws were interpreted and interacted with in distinctly local ways. Examination of the human experience of transporting and raising macaws reveals previously unconsidered challenges for keeping macaws. Overall, variation in the acquisition and deposition of scarlet macaws indicates changing strategies for placemaking in the SW/NW between 900 and 1450 CE.

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It has been my experience that pursuing a doctoral degree in archaeology is one of the most selfish things a person can do. It requires years of focused and specialized study, international travel for fieldwork, high highs, and low lows. So, the people and organizations who enable someone to pursue such an undertaking must be among the most selfless, supportive, and thoughtful. My case is no exception and this dissertation is testament to the many intelligent and insightful mentors, colleagues, friends, and family members that have supported me over the course of this project.

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INTRODUCTION

Exchange is a fundamental human behavior. It occurs through time and across space, and structures interactions amongst humans in all parts of the world (Algaze 1989; Ericson and Earle 1982; Ericson and Baugh 1993; Hirth 2016; Horan et al. 2005). Today, modern technologies have enabled the digital exchange of information over great distances in seconds. Though past networks were not as extensive as contemporary globalized networks, archaeological evidence suggests that people created and maintained networks capable of transporting objects, materials, and ideas over thousands of kilometers (Jennings 2010). Given the challenges associated with transporting objects over long distances in the past, the creation and maintenance of exchange networks required the mobilization of vast resources with substantial transport costs. Within this context, archaeologists examine long-distance exchange—the procurement of objects and materials from far away locales—to understand changing systems of human social interaction over time. In this dissertation, I explore the dimensions of rare, non-local objects that gave them significance in local contexts to answer why people acquired these objects and how they had transformative local influences.

This research sits at the intersection of long-distance exchange, human-animal interaction, and processes of placemaking that integrated regional centers in the pre-Hispanic United States (U.S.) Southwest and Mexican Northwest (hereafter, SW/NW). In the pages that follow, I explore the acquisition, treatment, and deposition of non-local scarlet macaws (*Ara macao*) at three regional centers in the SW/NW: Pueblo Bonito (900-1150 CE) in northwestern New Mexico, Wupatki (1080-1220 CE) in north-central Arizona, and Paquimé (1150/1200-1450 CE) in northwestern Chihuahua. To do this, I use an Archaeology of the Human Experience approach and combine radiogenic strontium isotope analysis with detailed contextual analyses using a Material Histories theoretical framework to (1) discern whether macaws discovered in the SW/NW were imported or raised locally, (2) characterize the acquisition, treatment and deposition of macaws at Pueblo Bonito, Wupatki, and Paquimé, and (3) identify patterns of continuity or change in acquisition and deposition of macaws over time and across space in the SW/NW.

This dissertation is comprised of three articles that build upon each other. In the sections that follow, I first introduce scarlet macaws and discuss their relevance in studying the archaeological past. I briefly recount the foundational work of Lyndon Hargrave, Charmion McKusick, and others who made this dissertation possible, and explore how scarlet macaws are tied up in the process of placemaking in the SW/NW. I then introduce the Material Histories theoretical framework used to weave together the three articles. Finally, I provide introductions for each of the chapters and describe how each contributes to the major research questions and central thesis of the dissertation. All of the chapters presented here were immeasurably shaped by an April 2019 Amerind Foundation Advanced Seminar on macaws and parrots in the SW/NW that I co-organized with Patricia Gilman and Stephen Plog. In an effort to engage with the most up-to-date research, citations of chapters written by seminar participants for the forthcoming volume (i.e., 2021) are incorporated throughout this dissertation.

Why Scarlet Macaws?

A recent New York Times article asserted that parrots are the "humans of the bird world" (Klein 2018). Parrot owners have observed their birds playing, singing, dancing removing their tracking devices, escaping their cages, mimicking the sounds of car alarms, and even impersonating celebrities (Angier 2016; Klein 2018). Researchers have found that parrots are capable of counting, opening complicated locking mechanisms, using tools, and doodling (Angier 2016). Indeed, *Psatticines*—birds of the parrot family—are capable of various characteristics and behaviors traditionally considered unique to humans. Even some changes in the human genome that set humans apart from other primates—larger brain size relative to body size, greater cognitive ability and longevity—are mirrored in the parrot genome (Klein 2018). It is thus unsurprising that we have and continue to be fascinated by macaws and parrots that mirror our own most engaging traits.

Of the many capable and interesting *Psittacines,* scarlet macaws are among the most beautiful, inquisitive, social, and temperamental. Even when compared with the largest macaw species, they are big; averaging a body length of 82-94 cm and a wingspan of 112-120 cm (Abramson et al. 1995). Their feathers are iridescent—red with vibrant shades of yellow and blue in the subspecies *Ara macao cyanoptera*, and also containing bands of green in the subspecies *Ara macao macao*. Scarlet macaw owners can teach birds to stack blocks, high-five, respond to questions, and return to their arms after a couple minutes (or hours) of flying. A brief search through internet forums will yield stories about scarlets escaping from their cages by learning how to operate the locking mechanisms. Scarlet macaws are also among the most temperamental, non-compliant of birds, and are often not afraid to show it. Scarlet macaw owners occasionally find themselves engaged in arguments with their birds, and scars on their hands and faces attest to the reactivity of the birds. Yet, their positive characteristics and intelligent, inquisitive nature have kept people engaged since pre-Hispanic times.

People—in the past and continuing today—were so captivated with scarlet macaws that they were compelled to transport them hundreds of kilometers from their endemic homeland. The natural range of contemporary scarlet macaws spans from the neotropical rainforests of South America to Central America, into southern Mexico, and north to the eastern gulf coast of Mexico. No environmental evidence indicates that this range varied greatly in the recent past. Though some groups of scarlet macaws are migratory (Brightsmith et al. 2018), individuals or groups of scarlets have never been observed traveling northward from their natural range into the SW/NW. It is this fact that makes the presence of over 500 scarlet macaws (and over 700 macaws and parrots) in the pre-Hispanic SW/NW particularly interesting. What did past people do with the birds? Why were the birds so important that they warranted long-distance transport? Who transported these birds? How did they do so? Where, or from whom, did they get them?

Scarlet macaws were not the only tropical bird recovered from SW/NW archaeological sites, but they were by far the most common. Military macaws (*Ara militaris*) and thick-billed parrots (*Rhynchopsitta pachyrhyncha*) are the most common non-scarlet specimens. Military macaws were relatively common at Paquimé (n = 81), but rare in the northern Southwest. Military macaws have also been recovered from the Mimbres region of southwest New Mexico and more recently, excavations of a cave in central Chihuahua revealed a well-preserved military macaw specimen that had been included in a burial deposit and naturally mummified (Zachos 2018). Thick-billed parrots occur throughout the SW/NW, including at all three regional centers discussed in this study. Though the natural range of military macaws and thick-billed parrots extends into Chihuahua and Sonora (Olsen 1967), morphological analyses (Hargrave 1970; Ruble 1996) later confirmed by the study of mitochondrial DNA (Bullock and Cooper 2002; George et al. 2018) suggest that the majority of tropical birds found in SW/NW archaeological contexts were scarlet macaws. The relative abundance of the imported birds demonstrates a preference for scarlet macaws over more locally-available species.

Various other lines of evidence suggest that macaws were socially, economically, and cosmologically valued throughout pre-Hispanic Mesoamerica and in the SW/NW. From the Maya region, to East, Central, and West Mexico, to the SW/NW scarlet macaws are depicted in architecture (Fash 1991; Freidel et al. 1993), cosmology (Tedlock 1985), ceramic iconography (Crown 1994; Rizo 1998; Searcy 2010), codices (Alcalá 2008; Nelson et al. 2021; Sahagún 2001), and tomb (Rizo 1998) and kiva murals (Greiser 1995; Hibben 1975; Smith 2005). Scarlet macaws were rich in symbolism and cosmological associations including (but not limited to) the color red, south, the sun, various deities, Venus, and agricultural ceremonies (for an exhaustive discussion of scarlet macaws and their symbolic associations throughout Mesoamerica and in the SW/NW, see Rizo [1998]). The importance of red, blue, and yellow scarlet macaw feathers is attested to in ethnohistoric accounts of widespread trade and exacted tributes in Mesoamerica (Guernsey 2006; Nelson et al. 2021; Rizo 1998) and the use of macaw feathers in ceremonies, on prayer sticks, and in ceremonial attire in the SW/NW (Bandelier 1890;

Crown 2016; Hargrave 1979; Tyler 1991). Somerville et al. (2010) attribute the hundreds of scarlets found at Paquimé to an economic system designed to meet increasing feather demands from people living to the north and Rizo (1998) agrees that feathers—and not necessarily the live birds—were the most important byproduct of macaw aviculture. Though rare, discoveries such as a well-preserved cape made with over 2,000 scarlet macaw feathers in southeastern Utah (Borson et al. 1998; Hargrave 1979) offer an enticing look at the use and importance of macaw feathers in the pre-Hispanic past.

Archaeological and ethnographic evidence also suggest that the birds themselves were quite important. The deposition of macaws at settlements throughout the SW/NW—often in greater numbers at large, central regional centers—indicates that their physical presence was considered a necessity. The study of morphological bone characteristics to determine age in archaeological macaws remains from SW/NW settlements (Hargrave 1970; McKusick 1974) indicated that most specimens were between ten and twelve months of age at death. This is perhaps the greatest evidence for the significance of the physical birds in the SW/NW because captive and wild scarlet macaws live relatively long lives (up to 50 years in captivity and 75 in the wild) and molt feathers naturally over time (Abramson 1995a; Chapter 2). I am not the first to point out that it would be much easier to procure naturally-molted feathers from a scarlet macaw throughout its lifetime than to remove all of the bird's feathers, thus killing the bird, then have to procure another scarlet macaw (Crown 2016:350). McKusick (1974, 2001) explained this by suggesting that the intentional sacrifice of scarlet macaws may have occurred as part of Spring Equinox ceremonies. The many associations of scarlet macaws (e.g., the sun, agriculture, fertility, the south) and their distant homeland in neotropical, water-abundant regions of the world make the argument for their sacrifice—in order to bring rain for agriculture—particularly enticing. However, this argument assumes that scarlet macaws hatch in March or April, which would make them eleven to twelve months of age by the following March. Crown (2016:348) points out that this assumption can be true in captivity given human control over breeding and light, but wild breeding seasons tend to vary with latitude, rainy seasons, and availability of fruit. She goes on to note various other concerns with McKusick's theory, including the common association of scarlet macaws with summer, the lack of Spring Equinox ceremonies amongst contemporary Pueblos, and the difficulty of procuring additional macaws (for a full discussion, see Crown 2016:348-351), but leaves the possibility open. She concludes by stating that "at most villages, scarlet macaws had more value in death than in life" (Crown 2016:350), which is a topic that emerges from contextual analyses presented in Chapter 4.

Finally, past scarlet macaws—like their contemporary counterparts that we see and hear today in zoos, on boardwalks, and with some luck, in the wild—were able to mimic human speech. Scarlet macaws are one of only a handful of bird species capable of this ability in North America (Abramson et al. 1995). They can repeat words and phrases and respond to cues to repeat phrases or complete actions. Some common behaviors include training macaws to respond to questions or say goodbye and wave when a person leaves a room (Chapter 2). A scarlet macaw given to the Macaw Clan at Zuni in 1924 by Neil Judd "spoke Zuni and knew the names of about twenty individuals" by 1939 (Crown 2016:335; Ladd 1963:17 cited in Whiteley [2021]). These abilities are rarely mentioned in archaeological discussions of scarlet macaws; probably due to the fact that most archaeologists are not interacting with live birds. At a time when humans—not computers, televisions, cell phones, radios, or even refrigerators—were the only beings capable of speaking, interaction with brilliantly-colored and vocal scarlet macaws would have been quite remarkable. Observing a live scarlet macaw speaking back and forth to specific people whose names the bird could recall, or interacting with people when asked to would have been incredible, though not unprecedented. Origin stories often feature animals-as-deities capable of communicating with humans (e.g., Guernsey 2006; Tedlock 1985, Whiteley 2021). In this context, experiencing a live scarlet macaw could have been perceived as a re-affirmation of worldview and cosmology.

Though my focus is the period of time between 900 and 1450 CE, the significance of scarlet macaws in the SW/NW is not only a past phenomenon. Crown (2016:335) notes that living scarlet macaws were kept at Zuni, Laguna, Isleta, San Felipe, and Santo Domingo as late as the nineteenth century. Macaw and Parrot Clans exist at Hopi, Zuni, Acoma, Laguna, Santa Clara, and Taos (Greiser 1995). Hopi oral history recounts the travel of Parrot people who migrated from tropical southern lands before settling on the Hopi mesas and the Parrot Clan is "the symbolic mother of all Hopi clans, entrusted with the power of fertility" (Greiser 1995:502). The Parrot Kachina and use of macaw and parrot feathers in the making of kachinas remain important in Hopi ceremonial life (Wright 1973). At Taos, macaw feathers are prized for their use in ceremonial headdresses and they are also used by the Keres groups, Acoma, and Zuni in dances, fetishes, and in other ceremonially important and animate objects (Greiser 1995:507). A Zuni origin story recounts the splitting of the nation into two groups of people, the Macaw-people (People of Summer) and the Raven-people (People of Winter) (Cushing 1896; Greiser 1995; Whiteley 2021). When the Sun Priest instructed people to choose between two turquoise-colored eggs and two earth/red-colored eggs, each containing “the seeds of living things”, most people rushed to choose the beautiful, turquoise eggs (Whiteley 2021). With time the people came to find that the beautiful eggs contained black, evil beings that filled life with the labor of the winter and the plain eggs contained colorful scarlet macaws that spread summer and fertility. Upon fledging, the ravens flew away mockingly while the scarlet macaws brought those who had chosen their eggs to the “southward southern land” (Cushing 1986). Whiteley (2021) points out that scarlet macaws not only feature pivotally in Zuni origin stories, but are also associated with the origins of social order. Greiser (1995) recounts a similar origin story and states that many people at Zuni still claim *Mukakwe* (or *Mullakwe*), Macaw-people or Macaw Clan, as their lineage and the Sun Priest is selected from this clan. Zuni’s Macaw Clan also controls salt deposits and oral traditions from Acoma recount the rewarding of control over salt deposits to people of the Parrot Clan (Greiser 1995). Finally, Whiteley (2021) points out the many, varied linguistic connections of macaws amongst the contemporary Pueblos. Though the presence of macaws and parrots may be uncommon in descendant SW/NW communities today, they continue to hold important roles in oral traditions, language, cosmology, and ritual practice manifesting in continued use of macaw feathers. Scarlet macaws, their many associations, and their byproducts are just one small collection of ideas and practices that connect the past to the present in the SW/NW.

Standing on the Shoulders of Giants

This dissertation draws on a far and wide set of previous research, some of which warrants further discussion here. The presence of scarlet macaws in the SW/NW, far from their natural habitat, is interesting enough to inspire further research, but without the foundational archaeological and archaeo-ornithological work of Lyndon Hargrave (1970) and Charmion McKusick (1974; 2001), it would have been impossible to study these birds using the comparative approach applied here. Lyndon Hargrave's landmark study *Mexican Macaws: Comparative Osteology and Survey of Remains from the Southwest* provided the means for zooarchaeologists to distinguish between the remains of scarlet macaws, military macaws, and thick-billed parrots, and provided a comprehensive listing of macaw remains throughout the SW/NW. Hargrave's use of bone morphological characteristics to differentiate species and age at death provided an enticing look into the exchange and ritual behaviors of past people. His comprehensive zooarchaeological analyses and recounting of contextual details of macaws from throughout the SW/NW provided researchers with the tools and inspiration to make systematic comparisons within and across regions in the SW/NW, as I do here.

Hargrave's (1970) study had three major findings: (1) Macaws recovered from archaeological sites in the SW/NW were predominantly scarlet macaws, (2) macaws were pervasive in the SW/NW, occurring in all of the major culture areas known at the time, and (3) most of the macaws found in the SW/NW were between eleven to twelve months of age at death—an age category that Hargrave called "Newfledged". In the 50 years that have passed since his study was published, the first two of these findings have held up to scrutiny. Bone morphological features continue to provide a means for zooarchaeologists to distinguish scarlet macaws from other macaws and parrots, and his species determinations have neem affirmed in ancient DNA studies of pre-Hispanic scarlet, military, and indeterminate macaws (*Ara sp.*) in the SW/NW (Bullock and Cooper 2002;

George et al. 2018). Hargrave's comprehensive zooarchaeological analysis of bone pathology and reporting of contextual details of macaw deposits compiled details from disparate, difficult to find reports and contributed to a much clearer understanding of pan-SW/NW macaw exchange patterns (see also Vokes and Gregory 2007). Though there have been some revisions to Hargrave's initial work, the regional patterns he describes have largely held up and continue to motivate research, as can be seen in this dissertation.

Recently, Hargrave's system for determining age in archaeological scarlet macaw remains has been called into question. Patricia Crown (2016) questioned Hargrave's age identification system by observing that young macaws actually fledge at around three months (not eleven to twelve months as Hargrave noted) and that, even more importantly, Hargrave only knew the actual ages of six of the twelve birds that he used to construct his age determination stages. To account for this, he extrapolated ages at death based on his observations of bone morphology that he had constructed to age the birds. Crown was not the first to make this observation (see Abramson 1995), but her critique was the most comprehensive and has led researchers to question the initial age designations made by Hargrave (for a complete discussion, see Crown 2016:346-348). Crown (2016:348) suggests that Hargrave's four to eleven month "Immature" age category may actually identify younger birds that are somewhere between ten and sixteen weeks in age. This uncertainty has led to a re-assessment of the idea that macaws were sacrificed around eleven to twelve months of age when their tail feathers are first fully grown, in conjunction with the Spring Equinox (Crown 2016). Researchers are now currently at work on refining age categories for scarlet macaws for archaeological study and it is for this reason that I mostly avoid using Hargrave's age categories to make inferences about macaw populations throughout this dissertation, and especially in my discussion of macaw populations at Pueblo Bonito, Wupatki, and Paquimé in Chapter 4.

The only region excluded from Hargrave's study was that of Casas Grandes, where Charmion McKusick was compiling the immense avian report for Paquimé (McKusick 1974). Her zooarchaeological work identifies age, species, pathologies, minimum faunal counts, and depositional context of each of Paquimé's 503 macaws and parrots. McKusick (1974:276-278) was the first to explore the significance of scarlet macaws to past and present tribes, and to use the characteristics of contemporary macaws to offer suggestions of how past people could have transported them; the latter inspired and is expanded on in Chapter 2. McKusick's work with birds in the SW/NW did not stop there: She analyzed avian remains for various projects (e.g., McKusick 1976, 1981, 1982, 1986a, 1986b) and eventually wrote *Southwest Birds of Sacrifice* (2001), which explored the various social, religious, and political aspects of human-bird interactions throughout the SW/NW. Her holistic and broad comparative approach—incorporating archaeological, ethnohistoric, and ethnographic data—highlighted the various dimensions of human interaction with of birds in the pre-Hispanic SW/NW and attested to the prevalence of birds in the past and in contemporary Puebloan ceremonial life. Though my emphasis is on exchange and placemaking, I draw on McKusick's holistic approach that incorporates the social, religious, political, and economic aspects that brought relevance to scarlet macaws in the SW/NW.

Long-Distance Interaction and Placemaking

Scarlet macaws are often discussed alongside a suite of objects, materials, and ideas observed in the SW/NW but considered to have been imported from parts of Mesoamerica. The rich history of interaction between these macro-regions extends to around 2100 BCE, when maize and associated agricultural practices moved northward through Uto-Aztecan language groups from part of central and southern Mexico into the SW/NW (Hill 2001; Merrill et al. 2009). By around 900 CE (and earlier in the Hohokam region), a series of Mesoamerican objects and ideas had reached the SW/NW. These rare and non-local objects included (but were not limited to) cacao, copper bells, scarlet macaws, shell bracelets, shell trumpets, and ideas manifested in architectural and ceramic styles, belief systems, and iconography (Bayman 2002; Crown and Hurst 2009; Di Peso 1974; Ericson and Baugh 1993; Hays-Gilpin and Hill 1999; Mathiowetz 2011, 2018; McGuire 2011; Mills and Ferguson 2008; Nelson 2006; Nelson 1991; Schaafsma 1999; Schaafsma and Taube 2006; Searcy 2010; Vargas 1995, 2001; Vokes and Gregory 2007; Wilcox 1991). Despite this substantial evidence for trade items moving north into the SW/NW, blue-green stone remains the only archaeologically recovered material class found in parts of Mesoamerica that suggests movement of goods in the opposite direction (Harbottle and Weigand 1992; Weigand 2008). Even so, recent geochemical study of strontium and lead isotopes in turquoise tesserae from Aztec settlements has suggested that instances of this blue-green stone recovered in parts of Mexico may actually have been procured locally (Thibodeau et al. 2018).

Researchers have documented occurrences and hypothesized meanings of Mesoamerican ideas and objects in the SW/NW (Lister 1978; McGuire 1980; Nelson 2006; Nelson et al. 2017). They have posited various explanations for the nature of long-distance interaction, including Mesoamerican domination, long-distance traders, migrations, and down-the-line exchange (Di Peso 1974; Kelley 1995; Vokes and Gregory 2007; Weigand and Harbottle 1993). To date, there is no agreed upon understanding of the nature of this long-distance interaction.

The complexity of Mesoamerican-SW/NW interactions has led researchers to the detailed study of object and material classes in order to examine their significance to SW/NW communities. Past studies of Mesoamerican-SW/NW interactions have focused on sociopolitical circumstances surrounding production, acquisition, and use of widely traded objects (Crown 2016; Gilman et al. 2014, 2019; Hosler 1994; Mathiowetz 2018; Watson et al. 2015). Others have examined the "sourcing" of non-local materials using object characteristics and biogeochemical approaches (Crown and Hurst 2009; Hedquist 2017; Hedquist et al. 2017; Somerville et al. 2010; Thibodeau 2012; Thibodeau et al. 2015, 2018). Because not all archaeologically recovered materials can be sourced, only a few studies have been able to explore contexts of acquisition and identify source areas. Still fewer studies can explore distant interactions through the physical remains of animals. Scarlet macaws provide a particularly informative window into the past given that their origins can be analyzed through biogeochemical methods and that past people likely interacted with them in different ways from inanimate classes of objects and materials—though in similar ways to modern human interactions with scarlet macaws. It is this window of combined source-ability and animacy through which this research explores the social significance and treatment of scarlet macaws and their relevance in placemaking in the SW/NW.

Recent studies (e.g., George et al. 2018; Gilman et al. 2014, 2019; Somerville et al. 2010; Watson et al. 2015) have shown the acquisition and procurement of scarlet macaws to be integral elements in processes of social change and the establishment of social complexity in the SW/NW. A study of stable carbon and oxygen isotopes by Somerville et al. (2010) explored the diets of 30 scarlet macaw specimens from Paquimé, finding that from a young age macaws were fed primarily maize and matured in a dry climate—a substantial departure from observed diets of fruits and nuts found in the humid lowlands of Mesoamerica. Findings from this study, coupled with archaeological evidence (such as the presence of eggshells, adobe cages, and cage associated stones) for large-scale macaw aviculture (Di Peso 1974; McKusick 1974; Minnis et al. 1993), led Somerville et al. to suggest that Paquimé's inhabitants bred macaws while also occasionally importing additional birds. Other scholars (Gilman et al. 2014, 2019; Watson et al. 2015) have suggested that the distant travel inherent in macaw acquisition from southern Mexico served to garner political prestige for local ritual leaders, at the same time associating them with supernatural forces. Travel from the Mimbres region of southwestern New Mexico into the distant parts of Mexico to acquire esoteric knowledge of macaws and their keeping would have resulted in increased prestige for those willing and able to make the distant and dangerous trip. Finally, George et al. (2018) recently analyzed mitochondrial DNA in scarlet macaw remains recovered from the Mimbres region and Chaco Canyon and found that a founding breeding pair must have existed whose offspring were distributed to settlements in these regions. Each of the macaws sampled in this study shared a rare genetic haplogroup (Haplo6) that is so distinct from contemporary wild macaws that there must have been a pre-Hispanic breeding population from which people acquired macaws prior to the establishment of Paquimé. These studies clarify that in parts of the SW/NW, macaw acquisition, production, and exchange were important elements of social, economic, and political life.

Even so, no comparative studies have systematically explored the acquisition, treatment and deposition of scarlet macaws over time at regional centers in the SW/NW. Watson et al. (2015) found that the importation of scarlet macaws at Pueblo Bonito preceded peaks in population aggregation and architectural expansion observed between 1040 and 1100 CE. The importation of cosmologically and economically important scarlet macaws from distant Mesoamerica did not emerge from, but rather was part of what led to the apogee of Chacoan social development. In contrast, the Zuni (Cibola) region flourished without acquiring scarlet macaws, despite being at the center of exchange networks that connected Chaco Canyon to the southern SW/NW (Vokes and Gregory 2007). Still, the presence of scarlet macaws at many regional centers between 900 and 1450 CE and their multi-faceted significance throughout the SW/NW suggest that they played a role in to region-wide social aggregation and processes of placemaking.

By placemaking, I refer to the continual constitution of place through "reiterative social practice" (Cresswell 2004:39). Cresswell (2004:39) states that space is made and re-made on a daily basis, and space—as well as the making of places—should be considered performed and practiced. Ceremonies and performances, knowledge (esoteric and mundane), traditions, and even daily activities are essential processes of placemaking that create and maintain communities (Helms 1991; Inomata 2006; Mills 2015). Objects and materials—especially rare, non-local ones— play integral roles in these processes by bringing legitimacy or authority to leaders, by virtue of their use in public ceremonies, through their sacrifice in opening or closing deposits, or in the origin stories and oral traditions that guide communities (Bishop and Fladd 2018; Hopkins 2012; Mills 2004, 2015; Mills and Ferguson 2008; Oka and Kusimba 2008; Sugiyama and Lopez Luján 2007; Weiner 1992). Oftentimes, by virtue of their procurement from or associations with distant locales, rare and non-local objects either carry themselves or bestow power unto those that have learned the knowledge of their use and care (Helms 1991, 1993; Spielmann 2002). Above, I noted the many dimensions (in cosmology, associations, as well as in preliminary patterns of treatment and deposition) that brought macaws significance in the SW/NW between 900 and 1450 CE and in the chapters that follow, I explore these processes in detail at three regional centers in the SW/NW: Pueblo Bonito (900-1150 CE) in northwestern New Mexico, Wupatki (1080-1220 CE) in north-central Arizona, and Paquimé (1150/1200-1450 CE) in northwestern Chihuahua.

Material Histories Theoretical Framework

To connect the many components of this research, I draw on the Material Histories framework outlined by Ann Stahl (2001, 2010). This framework explores the entanglements and evolving significance of material culture through three complementary approaches: Biography, deposition, and genealogy. *Biographical approaches* refer to the many varied associations of material objects as they are circulated amongst contexts and various spatial scales (Appadurai 1986; Giomi and

Peeples 2019; Gosden and Marshall 1999; Kopytoff 1986; Stahl 2008; Thomas 1991). Throughout a lifetime, objects accrue and change meaning, significance, and use, which come to reciprocally affect human behaviors and influence treatment and deposition. A major focus of biographical approaches—of particular relevance to interregional exchange of scarlet macaws—is how objects are produced in one context and re-contextualized as they are brought to another place and time (Geary 1986; Kopytoff 1986; Thomas 1991). Examination of *deposition* identifies the ways in which objects are brought together in specific contexts and highlights how objects of diverse backgrounds can be combined to form novel relationships that influence, express, or constitute human experiences. Comparative studies of deposition have allowed archaeologists to assess a range of contexts and object combinations, permitting the construction of object biographies that inform how the circulation of objects influences social relations (Stahl 2008). Finally, *genealogical approaches* are concerned with "...the reproduction and transformation of practice in time" (Joyce and Lopiparo 2005; Stahl 2010). Specifically, genealogical approaches assess how continuity and discontinuity of objects and materials condition human behavior and foster social practice over time.

Stahl's Material Histories framework has previously been applied primarily to contexts in West Africa, where Banda material interactions are produced and reproduced over hundreds of years of inhabitation and reciprocally influenced by the introduction of European colonizers and their material culture (Stahl 2001, 2008). For example, between the fourteenth and nineteenth centuries Banda ritual practice shifted through political-economic transformations. By focusing on material ritual practices of daily life, Stahl observed discontinuity in the bundling of objects—especially between the sixteenth to seventeenth century when animal bones and grinding stones replaced ceramic shrine bundles, which typically incorporated objects linked to production, locally produced ornaments, and imported objects. By exploring the biographies of the sacrificed animals, Stahl (2008, 2010) found patterns in differential deposition of animal elements that were indicative of hierarchy and social distinctions. Continuity of dog sacrifice after the seventeenth century at sites with ceramic shrine bundles demonstrated the complexity of material-ritual behaviors as well as the presence of previously unknown communities of practice in spite of larger transformations already thought to be well-understood (Stahl 2008, 2010). This framework provides a deeper understanding of human interaction with objects and materials, the ways in which objects and people are bound in global connections, and the effect of changing socio-historical processes on perceptions and practices through the modern day.

In the research that follows, I adapt the Material Histories framework to examine the acquisition, treatment, and deposition of scarlet macaws in placemaking at three regional centers in the SW/NW. To understand the biographies of scarlet macaws in the SW/NW, I use an Archaeology of the Human Experience approach (Hegmon 2016a, 2016b) that examines the human interactions with macaws in transporting and raising scarlet macaws in the SW/NW (Chapter 2). Whether they were raised locally or imported from their distant homeland is one integral element to understanding macaw biographies, so I use radiogenic strontium isotope analysis to assess the origins of scarlet macaws recovered from Pueblo Bonito, Wupatki, and Paquimé (Chapters 3 and 4). The second component of the Material Histories framework, deposition, is assessed in my analysis of the treatment and deposition of scarlet macaws in all three case studies in Chapter 4.

Finally, I assess genealogy by exploring patterns of continuity or change in the acquisition, treatment, and deposition of scarlet macaws at Pueblo Bonito (900-1150 CE), Wupatki (1080-1220 CE), and Paquimé (1200-1450 CE). Together, these components provide a detailed look at the role of rare, non-local scarlet macaws in processes of placemaking at regional centers in the SW/NW over time.

Chapter Introductions

The Human Experience of Transporting and Raising Scarlet Macaws at Paquimé in Northern Chihuahua, Mexico

Chapter 2 uses Archaeology of the Human Experience as a biographical approach to explore what transporting and raising scarlet macaws would have been like for past people. To do so, we draw on archaeological and ethnohistoric accounts of long-distance trade and travel, human-interactions with macaws, archaeological evidence of aviculture at Paquimé, contemporary macaw biology, and years of experience handling and raising macaws. We point out many challenges associated with the transport and raising of scarlet macaws in the past and offer some solutions for how macaw keepers could have been successful. This chapter contributes to understanding the biography of scarlet macaws and the humans that kept them. It points out the human costs associated with macaw transport and care as well as many of the dimensions that brought scarlet macaws significance in the past, and addresses how central macaws and their care would have been to daily life and placemaking in the pre-Hispanic SW/NW. This chapter will be published in the forthcoming edited volume about macaws and parrots in the SW/NW (Schwartz et al. 2021).

Long-distance interaction between Mesoamerica and the SW/NW has long interested archaeologists working in these regions (e.g., Bandelier 1890; Haury 1976; Lister 1978; McGuire 1980; Nelson 2006; Stanislawski 1963). The prevalence of rare, non-local objects such as copper bells, shell trumpets, and scarlet macaws at SW/NW regional centers between 900 and 1450 CE offers enticing hints of interregional interaction and long-distance connectivity over thousands of kilometers. Mesoamerican and Mesoamerican-like ideas that accompanied these objects and materials appear to have spread quickly throughout SW/NW communities, indicating an ideological as well as a material significance to local communities that continues even today (McGuire 2011; Mills and Ferguson 2008; Vokes and Gregory 2007).

Over time, archaeologists have offered various explanations for how non-local ideas and materials entered and circulated in the SW/NW. Large quantities of non-local objects and the presence of Mesoamerican-like architecture led researchers working in the Casas Grandes, Hohokam, and Chaco Canyon regions to suggest that settlements in these regions must be Mesoamerican outposts or colonies founded by people from the south (Di Peso 1974; Di Peso et al. 1974; Haury 1976; Kelley and Kelley 1975). For instance, hundreds of pieces of copper ornaments, turquoise pieces, scarlet macaws, and millions of pieces of marine shell alongside Mesoamerican-style ballcourts and platform mounds at Paquimé in northwestern Chihuahua led Charles Di Peso (1974; Di Peso et al. 1974) to suggest that Mesoamerican traders founded the site. Others (Creel and McKusick 1994; Harbottle and Weigand 1992; Plog et al. 1980) have proposed down-the-line exchange as a mechanism for the movement of non-local objects and materials into the SW/NW. More recent and intensive intraregional archaeological work has led other researchers to reject theories of colonization and adopt perspectives of local development, whereby regional centers developed out of regional traditions that acquired non-local goods in local economies (McGuire 1980), through long-distance acquisition (Gilman et al. 2014, 2019), or through traveling merchants (Kelley 1986, 2000). Overall, this paints a very complex picture of interregional interaction and long-distance exchange in the SW/NW.

Given this complexity, more recent approaches have turned to the detailed study of non-local objects and material classes to better understand the objects and the exchange networks through which they traveled. These approaches use compositional and isotopic analyses to locate zones of production or acquisition (Hosler 1994; Thibodeau et al. 2018), explore the multifaceted dimensions of non-local objects and ideas that brought them significance to past people (Bayman 2002; Gilman et al. 2014, 2019; Hosler 1994), and explore the significance of specific objects in interregional exchange networks (Vargas 2001; Vokes and Gregory 2007). These approaches have largely been successful, but such a detailed focus on the characteristics of a single object or material risks losing sight of the humans who were so compelled to procure an object that they were willing to transport an object over hundreds of kilometers or reproduce it far from where it originated. What was it like for people transporting objects over long distances? What challenges would people experience while traveling? How much could they carry? Was it dangerous?

Scarlet macaws are a particularly good lens into human experience in the past because macaw biology hasn't fundamentally changed in the time since macaws were introduced to the SW/NW. Thus, people transporting and raising macaws in the past would likely have faced similar challenges (such as providing food and water, preventing the macaws from flying away, and keeping them alive) that contemporary macaw keepers face today. This research is part of an emerging paradigm called Archaeology of the Human Experience (AHE), which focuses on what daily life was like in the past that archaeologists study. Michelle Hegmon (2016a) notes AHE's several components: "(1) Investigating the conditions of life; (2) Understanding how those conditions came to be; (3) Considering how those conditions are part of, and affect, the larger social and cultural context; and (4) Exploring the experience of those conditions" (Hegmon 2016b). These types of questions are not new, but AHE focuses on the more mundane, but relatable, aspects of past life, such as how far people would have to travel to access public services (Dennehy et al. 2016) or the labor required to transport pottery (Wichlacz 2018). We know that people travelled long distances to acquire copper bells and marine shell, but the actual transport of these objects would have been relatively straightforward. Large, animate macaws would have been a completely different story.

To address these questions, we use ethnohistoric accounts of human-macaw interactions, archaeological understandings of exchange and long-distance transport of objects in Mesoamerica and the SW/NW, archaeological evidence of large-scale aviculture at Paquimé, contemporary macaw biology, and experience from years of handling and raising scarlet macaws. Through this biographical approach, we point out the many challenges for transporting and raising macaws in the past and point out some potential solutions that humans could have employed. From this research come new ideas about the challenges of transporting macaws in the past, how macaws would have figured in to daily life at Paquimé, and even potential threats to human health that large-scale aviculture can pose.

Investigating Pre-Hispanic Scarlet Macaw Keeping Through Radiogenic Strontium Isotope Analysis at Paquimé in Chihuahua, Mexico

Chapter 3 addresses the question of scarlet macaw acquisition through radiogenic strontium isotope analysis as a biographical approach to understand whether scarlet macaws at Paquimé were locally raised or procured from their distant endemic homeland to the south. Both outcomes have important implications for understanding the significance of scarlet macaws to people living in the pre-Hispanic SW/NW and the role of scarlet macaws in placemaking. The results of radiogenic strontium isotope analysis on bone tissue from 30 scarlet macaws recovered from Paquimé suggest that despite substantial evidence for local raising of scarlet macaws at the site, there is some variability in macaw acquisition strategies. That macaws were primarily locally raised at Paquimé aligns with archaeological evidence, but the finding that Paquimé was also acquiring macaws from intra-regional and extra-regional locales is surprising. Overall, this chapter addresses acquisition as a second component of the biographical approach and reveals that the acquisition and raising of scarlet macaws were central elements of daily life at Paquimé and in the Casas Grandes region. This chapter will be submitted to *Journal of Anthropological Archaeology*.

The large, ceremonial center of Paquimé (1150/1200-1450 CE) in the Casas Grandes region of northwestern Chihuahua sits at the center of discussions of long-distance exchange and interaction between Mesoamerica and the SW/NW. This regional center sits geographically between the traditional SW and the northern Mesoamerican frontier and in its construction blends traditionally Mesoamerican and SW/NW architectural elements (e.g. I-shaped ballcourts, platform mounds with T-shaped doorways and pueblo-style compounds) (Minnis and Whalen 2015; Searcy 2010; Whalen and Minnis 2001a, 2003). Pottery (Di Peso et al. 1974), rare objects (Di Peso 1974; Rakita and Cruz 2015), ideas (Harmon 2006; VanPool et al. 2007, 2008), and people (Offenbecker 2018) from both regions all appear to have made their way to Paquimé. Many of the rare objects and materials reached Paquimé in quantities that were unprecedented in other parts of the SW/NW. This access to rare and non-local materials, such as copper bells, marine shell, turquoise, and scarlet macaws, has led many researchers to characterize Paquimé as a regional exchange center (Di Peso 1974; Whalen and Minnis 1996, 2001a, 2001b, 2001c, 2003).

Substantial evidence for large-scale macaw aviculture indicates that macaw raising and perhaps breeding were central elements to Paquimé's political and ritual economies. The remains of over 500 macaws have been recovered at Paquimé, including 322 scarlet macaws, 81 military macaws, and 100 indeterminate macaws. Their remains were deposited in burials that were scattered across the site and many were placed directly underneath Paquimé's plazas, which contained adobe cages for the keeping of macaws (Di Peso 1974; McKusick 1974). The presence of at least 56 adobe cages and circular cage stones indicates that many macaws could have been kept at the same time (Di Peso 1974; Rakita and Cruz 2015). These circular cage stones have also been found at surrounding Casas Grandes settlements (Minnis et al. 1993). Finally, a study of stable carbon and oxygen isotopes in Paquimé macaw bone tissue by Somerville et al. (2010) found that while most scarlet macaws appeared to have been raised locally and fed largely C_4 plants (e.g., maize; a departure from their predominantly C_3 diet observed in the wild), isotopic values of a few outlying specimens suggested that macaw keepers at the site likely maintained exchange ties with macaw source areas.

Given the significance of scarlet macaws to Paquimé and its central location geographically and in discussions of Mesoamerican-SW/NW interaction, the question of whether macaws were locally-raised or acquired from elsewhere has important implications for understanding how rare, non-local objects were acquired, produced, and/or used in the development of Paquimé as a regional center. To address these questions, I use radiogenic strontium isotope analysis on the same sample of bone tissue from 30 scarlet macaws that Somerville et al. (2010) analyzed. Findings from this study indicate that macaw acquisition and production at Paquimé was more complex than initially thought and support the presence of other scarlet macaw populations within the SW/NW from which Paquimé received birds, as has been suggested by a separate study of pre-Hispanic scarlet macaw mitochondrial DNA (George et al. 2018). These findings attest to the complexity of pre-Hispanic exchange practices in North America.

Scarlet Macaws, Long-Distance Exchange, and Placemaking in the U.S. Southwest and Mexican Northwest, ca. 900-1450 CE

Chapter 4 is the culmination of research conducted in this dissertation and involves the application of the Material Histories theoretical framework to the investigation of scarlet macaws in placemaking in the SW/NW between 900 and 1450 CE. This framework is adapted for use on the case study of scarlet macaws in the SW/NW by incorporating results from radiogenic strontium analysis of scarlet macaw remains from Pueblo Bonito (900-1150 CE) and Wupatki (1080-1220 CE) to those from

Paquimé (1150/1200-1450 CE) already discussed in Chapter 3. Together, these analyses serve as a biographical approach that assesses macaw acquisition. Detailed contextual analyses to explore the treatment and deposition of scarlet macaws at all three case studies comprise the deposition element of the Material Histories framework. Finally, genealogy is explored by comparing the acquisition and deposition of scarlet macaws through time and across space. Though a discussion of the human experience of transporting and raising scarlet macaws is absent in this chapter, findings from Chapter 2 inform the data analysis and interpretation. This chapter will be submitted to *American Antiquity*.

Holistic approaches to understanding exchange in the past incorporate economic, social, and political conditions that motivate actors (Oka and Kusimba 2008:341). Ethnographically and historically, non-local objects and materials are valued for a combination of these conditions (Helms 1993, 2014; Mauss 1925; Oka and Kusimba 2008). However, explanations for long-distance exchange in the ancient past often highlight only its economic component, largely ignoring the social, cosmological, and political relevance that distantly traded objects and materials held. We know from ethnohistory and ethnography that rare objects and materials from distant locales that humans transport through long-distance networks are often imbued with supernatural, mystical, and powerful characteristics derived from their distant origins in "unknown realms" (Carr 2005:583; Helms 1993:334). These objects can hold particular significance as animated sources of supernatural, ideological, and/or political power, which contributes to unique patterns of acquisition, exchange, treatment, and deposition. Indeed, the nature of long-distance exchange often transcends purely economic transactions and can be essential to the formation and maintenance of central places. To contextualize these practices, it is essential to distinguish the interactions and characteristics of objects that give them social relevance.

Often it is through the diverse interactions amongst social actors and objects, or the specific material components of an object that its meanings are constructed. Over time, specific objects can acquire biographies in which interactions with people, events, and other objects alter their meanings (Gosden and Marshall 1999; Kopytoff 1986). The material components and attributes of an object can affect the networks through which the object travels and its significance in different locations (Alberti and Bray 2009; Saunders 1999). Archaeological understandings of the categories (e.g., commodities, gifts) into which distantly acquired and exchanged objects fall are often fluid and contextually-dependent (Appadurai 1986). Thus, examination of the specific characteristics, attributes, and social relations of rare material objects can clarify elements of their significance to past people. Iridescent scarlet macaws native to southern Mexico and Central America but found thousands of kilometers to the north in the SW/NW are a particularly strong example of rare objects with non-local associations. Extensive archaeological evidence in the SW/NW for widespread feather trade, ritual sacrifice, local raising, and presumably distant procurement make macaws great case material for exploring the transformative local impacts of non-local objects in processes like placemaking.

The widespread discoveries of scarlet macaw skeletal remains at major regional centers in the SW/NW indicate that macaw acquisition, exchange, and deposition played an integral part in processes of placemaking. The large scarlet macaw population in the

SW/NW existed at Paquimé in northwestern Chihuahua, where evidence for macaw production occurred throughout the large settlement. Paquimé was once believed to have supplied the entire SW/NW with macaws (Di Peso et al. 1974). Revisions to the initial chronology of the settlement, which dated its founding to 1060 CE, have pushed back the establishment of the site to 1150/1200 CE (Dean and Ravesloot 1993). In either case, aviculture at Paquimé could not explain the presence of scarlet macaws at regional centers in the SW/NW as early as 600 or 700 CE (Hargrave 1970; Haury 1976). Radiocarbon dating of scarlet macaw remains from Pueblo Bonito, at Chaco Canyon in northwestern New Mexico, shows that the importation of scarlet macaws preceded peaks of architectural expansion and population aggregation between 1040-1100 CE (Watson et al. 2015). Watson et al. conclude that the acquisition of ideologically and economically important macaws, which drew on distant forces in Mesoamerica, transformed elite legitimization of power, leading to the apogee of Chacoan social development. Additionally, the largest quantity of macaw skeletons in the SW was discovered well west of Chaco Canyon at Wupatki Pueblo, a relatively understudied twelfth century community located 40 kilometers northwest of Flagstaff, Arizona. Wupatki drew on architectural and ideological elements from the Hohokam regional system to the south (e.g., ballcourts, exchange of shell jewelry), and the Chaco regional system (e.g., kivas, T-shaped doorways, importation and deposition of rare, non-local objects like scarlet macaws) to the east in its establishment as a regional center following the eruption of Sunset Crater around 1080 CE (Colton 1932, 1960; Elson et al. 2007, 2011; Stanislawski 1963).

To examine the significance of scarlet macaws in processes of placemaking at three regional centers, I use a novel theoretical framework for combining theoretical elements of material culture studies alongside biogeochemical methods. I borrow Ann Stahl's (2001, 2010) Material Histories theoretical framework, which incorporates three complementary approaches: Biography, deposition, and genealogy. I adapt Stahl's framework by using radiogenic strontium isotope analysis to examine macaw and parrot acquisition as a biographical approach. I collect detailed contextual data from the deposition contexts of macaws and parrots to explore deposition. Finally, I explore the genealogy of human-macaw interactions by comparing the acquisition, treatment, and deposition of macaws and parrots over time and across space in the SW/NW. Overall, variation in the acquisition and deposition of scarlet macaws indicate changing strategies for placemaking in the SW/NW between 900 and 1450 CE. Despite some similarities in macaw acquisition, variability in deposition at all three case studies indicate that non-local scarlet macaws were interpreted in distinctly local ways.

Conclusion

In the final chapter, I synthesize the results of the three papers presented in this dissertation and outline its methodological and theoretical contributions to the study of exchange in the past. This study employs a novel methodological framework that integrates Archaeology of the Human Experience, isotope biogeochemistry, and detailed contextual analyses through a Material Histories theoretical framework. This combination of approaches yielded important insights into reciprocal interactions amongst past humans and macaws, local interpretations of non-local objects, and variability in placemaking strategies over time and space in the pre-Hispanic SW/NW. While there are some similarities in the acquisition, treatment, and deposition of scarlet macaws between Pueblo Bonito and Wupatki, patterns observed at Paquimé differ considerably, which suggests varying local interpretations of scarlet macaws. I consider these findings within the context of Hopi and Zuni traditional histories and clan migrations involving scarlet macaws and I draw together the patterns observed in this dissertation that characterize placemaking in the SW/NW. Finally, I explore various avenues for future research that opened up over the course of this study.

Chapter 2:

THE HUMAN EXPERIENCE OF TRANSPORTING AND RAISING SCARLET MACAWS AT PAQUIMÉ IN NORTHERN CHIHUAHUA, MEXICO

Christopher W. Schwartz, Kelley L.T. Taylor, & Michelle Hegmon

Introduction

As early as 600-700 CE, scarlet macaws (*Ara macao*), along with other objects and material classes, began to circulate as far north as the United States Southwest and Mexican Northwest (SW/NW) from southern parts of Mexico and possibly Central and South America (McKusick 2001; Vokes and Gregory 2007). Though this was not the first time that objects, architecture, or ideas made their way into the SW/NW from distant locales to the south, it marked a point at which various non-local objects and materials (e.g., scarlet macaws, copper bells, shell trumpets) began to circulate consistently throughout this region (Vokes and Gregory 2007). The circulation of these non-local objects and ideas lasted well after Spanish contact and many remain significant to indigenous communities of the SW/NW today (e.g., Mills and Ferguson 2008).

Archaeologists have proposed various explanations for how non-local ideas and objects entered and circulated through the SW/NW. Large quantities of Mesoamerican-like objects excavated by Di Peso (1974; Di Peso et al. 1974), Haury (1976), and Kelley and Kelley (1975) led them to initially suggest that the Casas Grandes, Hohokam, and

Chaco Canyon traditions began as Mesoamerican outposts or colonies. Other scholars (Creel and McKusick 1994; Harbottle and Weigand 1992; Plog et al. 1980) proposed down-the-line exchange—transport of objects or ideas from one group to the next—as a mechanism for how non-local objects reached the SW/NW. Later, more intensive regional archaeological work in the SW/NW led some scholars (e.g., McGuire 1980; Minnis 1988; Whalen and Minnis 2001a; 2001b; 2003) to reject theories of colonization from Mesoamerica and adopt perspectives of local development. In these explanations, regional centers developed out of local traditions that acquired non-local goods in the following ways: (1) Leaders that manipulated the movement of non-local goods in local economies (prestige-goods economy) (McGuire 1980), (2) individuals or groups traveling long distances in search of material evidence of having acquired esoteric knowledge (long-distance acquisition) (Gilman et al. 2014), and (3) traveling merchants that moved non-local objects from place-to-place (regional market systems) (Kelley 1986, 2000).

Recently, it has become clear that the networks through which objects and people moved between the SW/NW and Mesoamerica were more complex than initially thought. Researchers have turned to the detailed study of singular objects and material classes to better understand the objects themselves and the networks through which they travel. This approach explores long-distance interaction in the past by using compositional and isotopic analyses to locate zones of production or acquisition (Hosler 1994; Thibodeau et al. 2015; 2018; Chapter 3; Chapter 4), examining multifaceted dimensions of non-local objects and ideas that drew people to acquire or adopt them (Bayman 2002; Gilman et al. 2014; 2019; Hosler 1994), and explore the significance of specific objects in larger interregional networks (Vargas 2001; Vokes and Gregory 2007). Such a detailed focus on the qualities and characteristics of a single object or material risks losing sight of the agents who were willing to transport objects hundreds of kilometers or re-produce them far from where they originated.

In this chapter, we place human experience in the forefront of archaeological discussions by exploring what it was like to transport and raise scarlet macaws in the past. Scarlet macaws are a particularly compelling example given that macaw biology has not fundamentally changed in the hundreds of years since macaws were first introduced to the SW/NW. Despite advances in time and technology, past macaw keepers would have faced the same challenges (e.g., food, temperament) that contemporary macaw keepers experience today. In this chapter, we draw together ethnohistoric accounts of human-macaw interactions, archaeological understandings of exchange and long-distance transport of objects in Mesoamerica and the SW/NW, archaeological evidence of aviculture at Paquimé (1200-1450 CE) in northwest Chihuahua, contemporary macaw biology, and years of experience handling and raising scarlet macaws. We point out the many challenges for transporting and raising macaws in the past and explore potential solutions that their human keepers could have employed.

Exploring Long-Distance Exchange through Archaeology of the Human Experience

The research presented here was developed as part of an emerging paradigm labelled the Archaeology of the Human Experience (AHE; Hegmon 2016a). AHE focuses on understanding what it was like to live in the past that archaeologists study. It has several components including, “(1) Investigating the conditions of life; (2) Understanding how those conditions came to be; (3) Considering how those conditions are part of, and affect, the larger social and cultural context; and (4) Exploring the experience of those conditions" (Hegmon 2016b). In large part, the AHE perspective is leading archaeologists to ask practical questions about processes that are already understood at some level. For example, instead of saying that Pueblo peoples in the past ate a diet that was 70 percent maize, AHE would ask how much corn you would have to eat to get 1,400 kcal (assuming a 2,000 kcal/day diet); the answer—about 2.5 liters of kernels or 0.75 liters of corn meal! Similarly, bioarchaeologists often observe and report on "cranial trauma," but the bioarchaeology of the human experience (Martin and Harrod 2016) also explore its effects on the injured individual, asking what their symptoms might be—blurred vision, memory loss, cognitive defects, etc.?

The questions asked by AHE are not entirely new, but they gained new focus as a result of the AHE perspective. For example, archaeologists have long asked how large items such as logs in the Southwest (McKenna and Windes 2001) or stone blocks in ancient Egypt (Stocks 2003) were prepared and transported. But AHE also asks about more mundane movement and transportation, for example the distance different categories of people would have had to travel to access ritual and market places in premodern cities (Dennehy et al. 2016) or the labor needed to transport pottery as part of the Hohokam regional system (Wichlacz 2018).

An Archaeology of the Human Experience inspires new kinds of questions about the movement of rare and precious items from Mesoamerica into the Southwest. People travelled long distances to obtain and move items such as copper bells, cacao, and certain kinds of shells. However, the actual transport of these inert items would have been relatively simple, as they are small, light, and could be carried in a bag or basket.

Macaws, however, are a different story. They are neither small nor light and could most definitely not be stuffed in a bag. Yet we know macaws were important in the Southwest and were—somehow—transported into the Southwest from Mesoamerica. Using AHE, we ask the deceptively simple question: How could macaws have been transported over such distances? This paper attempts to answer in several respects, considering the nature of transport, the human skills and labor, physiology and behavior of macaws, and the necessary technology.

Why Transport Scarlet Macaws?

Understanding the pre-Hispanic transport of scarlet macaws has been a compelling challenge for archaeologists. Although their nearest natural habitat is over 1,500 km to the south in northern Veracruz (Figure 1), hundreds of scarlet macaws have been recovered from archaeological contexts in the SW/NW (Crown 2016; Howell and Webb 1995). Morphological analyses conducted by Lyndon Hargrave (1970), and later confirmed by studies of macaw mitochondrial DNA (Bullock and Cooper 2002; George et al. 2018), clarified that though the natural ranges of the predominantly green military macaw (*Ara militaris*) and thick-billed parrot (*Rhynchopsitta pachyrhyncha*) extend as far north as Chihuahua and Sonora, scarlet macaws are much more common in SW/NW archaeological deposits. The abundance of imported birds demonstrates a preference for scarlet macaws over locally available birds, despite—or perhaps because of—the great challenges associated with procuring them.

Additional lines of evidence suggest scarlet macaws and their feathers were socially and economically valued in the SW/NW. Scarlet macaws were rich in

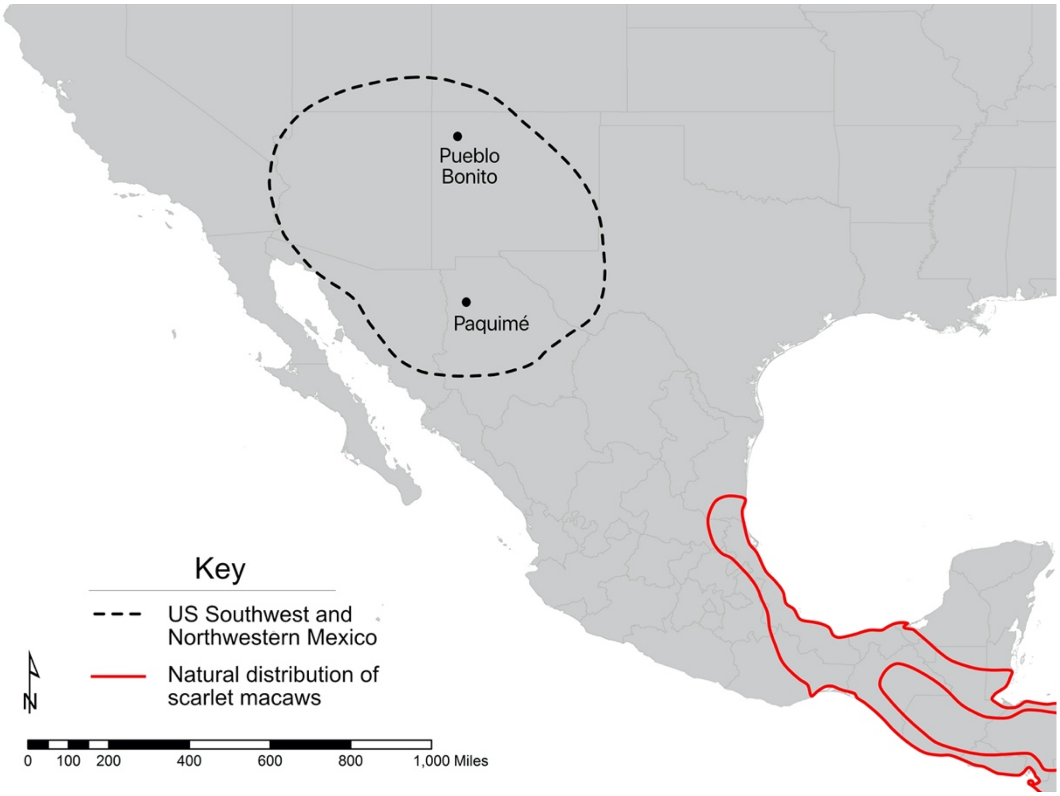


Figure 1. Contemporary geographical range of scarlet macaws and sites included in text.

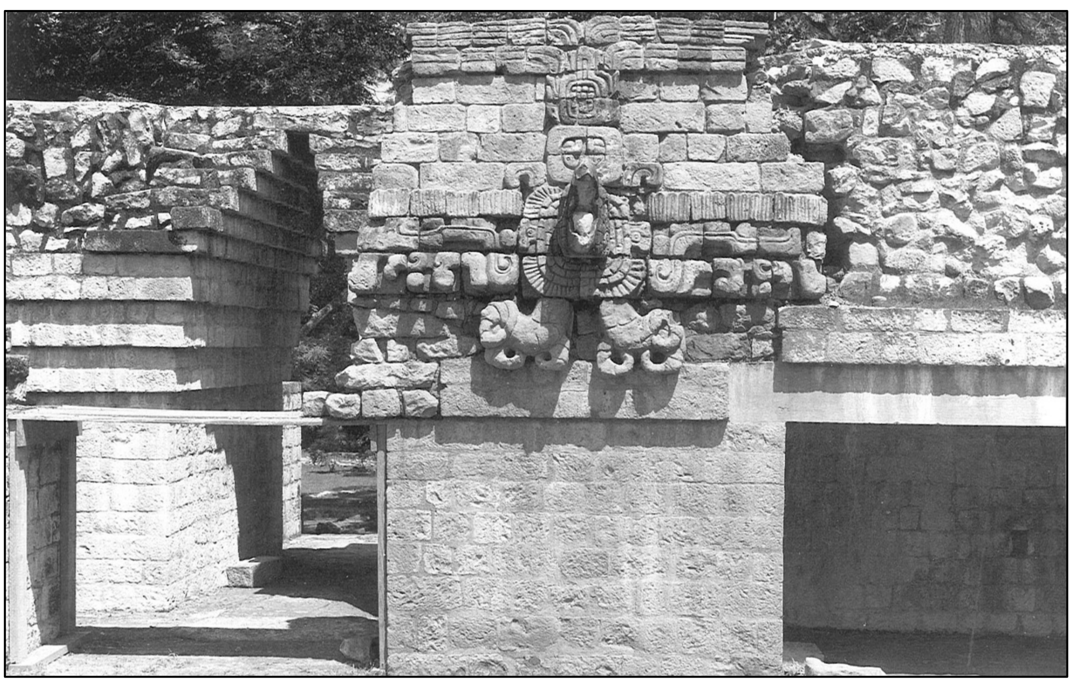


Figure 2. Macaw imagery in Structure 10L-10, adjacent to the Main Ballcourt (III-A) at Copán (from Fash 1991:125, Fig. 80).

cosmological associations and symbolism (i.e., red, south, the sun, fire, light, lightning, rain, Venus, rulership, salt, and salt-gathering) ranging in time and space from the pre-Hispanic Maya region to contemporary Pueblos (McKusick 2001; Rizo 1998; Tyler 1991). Within this geographic range, they figured prominently into pre-Hispanic worldview as important mythic deities and were depicted in iconography and architecture (Rizo 1998; Tyler 1991; Figure 2). Ethnohistoric and ethnographic records attest to the importance of iridescent macaw feathers (Bandelier 1890; Crown 2016; Guernsey 2006; Rizo 1998). Somerville and co-authors (2010) attribute the 322 scarlet macaws and evidence for large-scale breeding at Paquimé to feather demand, suggesting that the importance of macaw feathers extends into pre-Hispanic times. Few instances of scarlet macaw feathers have been found in the SW/NW, but historic accounts of feather exchange from Mesoamerica note that Aztec and Tarascan leaders exacted tributes in the form of scarlet macaw tail feathers (Guernsey 2006) and mobile traders transported feathers throughout central and west Mexico (Townsend 2000:195). Macaw feathers were used in Mesoamerican ceremonial paraphernalia and attire (Guernsey 2006), and an example of a macaw feather cape was recovered in southeastern Utah (Hargrave 1979). Living scarlet macaws were actively kept at a number of Pueblos as late as the nineteenth century and some Pueblos retain parrot and macaw clans to this day, suggesting the birds themselves—not just their feathers—were essential to Pueblo cosmology (Crown 2016; Whiteley 2021).

Morphological studies of scarlet macaw bone recovered from the SW/NW between 700-1500 CE suggest that most macaws died between ten and twelve months of age (Crown 2016; Hargrave 1970; McKusick 1974:275; 1982; Olsen 1990; Ruble 1996;

Whittlesey and Reid 2013; Wyckoff 2009). This pattern challenges the assumption that macaws were imported exclusively for their feathers because scarlet macaws regularly live 50 years in the wild (and up to 75 in captivity) and living birds naturally molt feathers throughout their lifetime. Charmion McKusick (1974, 2001) attributes the early age at death to the intentional sacrifice of scarlet macaws in association with a Spring Equinox ceremony, though recently Patricia Crown (2016) has strongly questioned this argument. Regardless of the reasons for their early deaths, burial of scarlet macaws in circular arrangements (McKusick 1974; Whittlesey and Reid 2013) and alongside humans (Hill 2000; McKusick 1974; Whittlesey and Reid 2013) suggests that human interaction with macaws extended into the afterlife. Interestingly, the preoccupation with killing or burying scarlet macaws in proximity to humans appears to be a uniquely SW/NW phenomenon as no examples of this behavior exist south of Paquimé (Nelson et al. 2021).

Finally, scarlet macaws have the ability to mimic human speech. This is rarely mentioned in archaeological discussions—indeed the birds archaeologists study are typically dead—but would likely have contributed to their significance. In addition to repeating words and phrases, scarlet macaws can also be taught cues at which to repeat phrases and specific behaviors to accompany speech, for example saying goodbye and waving when someone leaves the room. Scarlet macaws are one of few birds with this capability found in North America. In conjunction with their bright, multicolored plumage and ability to fly, it’s not hard to see why scarlet macaws might have been viewed as deities by people in the past.

Scarlet macaws were not the only things transported over long-distances between parts of southern Mexico and the SW/NW. Researchers have long considered scarlet macaws as part of a suite of objects, materials, architectural styles, iconography, and ideas that moved between these regions, including cacao, copper objects, pseudo-cloisonné decoration, shell trumpets, ballcourts, platform mounds, and the feathered serpent (DiPeso 1974; Harbottle and Weigand 1992; Haury 1945; Hill 2001; Kelley 1971, 2000 Lister 1978; McGuire 1980, 2011; Merrill et al. 2009; Nelson 2006; Nelson et al. 2017; Vokes and Gregory 2007; Weigand et al. 1977; Wilcox 1991). These connections are oftentimes considered Mesoamerican objects and ideas that were transported into the SW/NW. It is becoming increasingly clear that while many of these objects and ideas moved south to north, there are important distinctions to be made between "interaction markers" (Nelson 2006) that required procurement from Mesoamerica and those that could be local re-interpretations of objects, architecture, and stylistic elements found in Mesoamerica, West Mexico, and elsewhere. Some objects, including cacao (*Theobroma cacao*), scarlet macaws, copper bells and shell trumpets (e.g., *Murex* sp., *Strombus* sp.) would have come from their natural range, which to current knowledge included parts of Mesoamerica and West Mexico (Crown and Hurst 2009; Gilman et al. 2014; 2019; Howell and Webb 1995; Mathiowetz 2018; Mills and Ferguson 2008; Vargas 1995). On the other hand, other objects and stylistic motifs including cylindrical jars, stone palettes, and the feathered serpent appear to be local interpretations of materials and stylistic elements seen to the south (Crown 2018; VanPool and VanPool 2007; White 2010).

This distinction becomes important when considering the experience of trading objects over long distances, because strictly non-local objects and materials are suggestive of exchange relations with specific regions. Evidence for extensive importation of copper bells (Rakita and Cruz 2015) and scarlet macaw breeding (Somerville et al. 2010) suggest that Paquimé in northern Chihuahua could have been the farthest south people traveled for these items after 1250 CE (but see Vargas 1995). George and co-authors' (2018) discovery of low genetic diversity in scarlet macaws sampled from the Chaco Canyon and Mimbres regions leads them to suggest that macaws were also bred in the SW/NW between 900-1200 CE, prior to the establishment of Paquimé. Ultimately, they agree with Crown (2016) that the pre-Hispanic inhabitants of the SW/NW probably undertook long-distance trips to procure scarlet macaws from southern and eastern Mexico while also relying on local breeding or raising centers. These findings imply two types of human interactions with scarlet macaws, including traveling with the birds over both short and long distances, up to 1,500 km; and living with, caring for, and possibly breeding the birds in areas far outside macaws' endemic range. Keeping the birds alive in both situations would have required substantial knowledge of macaw biology and behavior. In the sections that follow, we draw on the literature and apply our knowledge of transporting and keeping scarlet macaws to archaeological examples from the SW/NW to explore the challenges and potential ways people living in the past might have cared for the birds.

Long-Distance Acquisition and Transport of Scarlet Macaws

Where Did People Get Scarlet Macaws?

Assuming the pre-Hispanic natural range of scarlet macaws is similar to that of today, the nearest source location would have been southern Veracruz in modern-day Mexico, over 1,500 km from northern Chihuahua (Howell and Webb 1995; Minnis et al. 1993). This location was part of the Huasteca, a region with a long history of raising macaws (Greiser 1995:508). As Gilman and co-authors (2014:95) point out, inhabitants of the SW/NW could also have accessed scarlet macaws along the Pacific coast of Mexico in Oaxaca. This would have required a journey of up to 1,800 km. Scarlet macaws can travel up to 25 km in search of food and up to 150 km in a day. Some, but not all, groups of scarlet macaws engage in long-distance seasonal migrations over several hundred kilometers (George et al. 2018; Iñigo-Elias 1996; McReynolds 2012; Renton 2002), though there is no current evidence that they would have naturally ventured into northwest Mexico.

Who Brought Them? Why?

There is no current consensus as to who was responsible for bringing scarlet macaws northward or the social mechanisms that enabled the movement of macaws. Evidence from studies of macaw keeping in the Mimbres region, at Chaco Canyon (George et al. 2018), and at Paquimé (Somerville et al. 2010) indicates that some scarlet macaws were raised in the SW/NW from 900 CE through 1450 CE. However, both of these studies suggest that local populations were likely supplemented with trips to procure additional macaws from as far as their neotropical homelands or as close as a breeding center within the SW/NW. Macaws recovered as early as 600-700 CE in the Phoenix Basin also suggest that trips to the south to procure scarlet macaws may have been made between 600-1450 CE in the SW/NW (McKusick 1976; Vokes and Gregory 2009). We review several inferences about scarlet macaw acquisition and consider the implications for their human transporters below.

Gilman and co-authors (2014 2019) argue for direct acquisition of scarlet macaws from Mesoamerica into the Mimbres region in southwestern New Mexico. They suggest that individuals seeking to gain prestige through their travel to distant lands and acquisition of remarkable objects and knowledge directly acquired scarlet macaws from their southern homeland. They draw on the work of Helms (1991) and Carr (2005) to argue that while participating in this long and dangerous journey, individuals making the trek acquired material objects (i.e., scarlet macaws), esoteric ritual knowledge related to macaw keeping, and elements of Mesoamerican worldview related to agriculture, water, and fertility in the form of the Hero Twins myth. These elements were brought northward to the Mimbres region, where they impacted Mimbres worldview and were depicted on Mimbres pottery.

Another potential mechanism for moving macaws northward is through the movement of traveling merchants. *Pochteca* is the name given to all Aztec merchants and *oztomeca* the term used by Sahagún to describe traveling vanguard merchants that heavily shaped the Aztec economy (Hirth 2016). *Oztomeca* traveled throughout Mexico acting in many capacities; (1) as specialist tradespeople that "…engaged in long-distance trade and procurement of wealth goods such as jade, feathers, and richly adorned textiles" (Hirth 2016:189), (2) as craftspeople that specialized in the production of rare goods requiring non-local materials, (3) as disguised agents of the state that traded in and reported on enemy territories, and finally, (4) as military guides and occasionally as warriors (Hirth 2016; Smith 2012; Townsend 2000). *Pochteca* and *oztomeca* occupied a separate social class between commoners and nobility that permitted the acquisition of high status, wealth, and special privileges such as serving as marketplace supervisors, judges, ambassadors, or administers of religious festivals (Hirth 2016; Smith 2012). *Oztomeca* often traveled in groups with several merchants alongside professional carriers and these trips could last months at a time (Hirth 2016; Smith 2012:115). Townsend (2000:193) notes that the earliest Aztec merchants carried red macaw feathers, and over time new objects were collected and transported (including cacao, cotton garments, jewelry, turquoise).

Pochteca or *oztomeca* merchants could have distributed scarlet macaws to specific settlements, or dispersed scarlet macaws over long distances into market systems. *Oztomeca* occasionally traveled long distances to procure objects and materials native to specific regions, or at least as far as markets in those regions (Hirth 2016). They would then transport these objects and materials to markets and sell them, even if the objects were previously unknown to local people. Thus, pre-Aztec traveling merchants could very well have been responsible for the introduction of scarlet macaws to the inhabitants of the SW/NW. If Aztec *oztomeca* did not carry scarlet macaws specifically, ethnographic records do note that other Mesoamerican traders transported the birds inter-regionally. Nelson et al. (2021) discuss the son of a traveling merchant who had transported feathers for commercial exchange from his home in contemporary coastal Veracruz to “big towns” approximately 800 km in a northern direction. In exchange of feathers, this merchant received silver and gold. In his consideration of the Aztatlán mercantile system, Kelley (1986:92) highlights Acaxee and Topia traders living along the northern Mesoamerican frontier that transported macaws and parrots and may or may not have been mobilized by any state system. Based on his analysis of assemblages at Cañon del Molino, Kelley (1986) suggests that Aztatlán traders moving between the SW/NW and west Mexico probably also transported desert fibers, cotton, copper trinkets, tobacco, tropical fruits and vegetables, dried fish, honey, beeswax, and feathers. In order to reach a distant destination safely and with all goods intact, people transporting macaws and other objects would have needed a wide knowledge of both the goods being transported and the diverse environments through which they were traveling.

What Was it Like to Travel with Scarlet Macaws?

What Was the Environment Like? Before embarking on such a journey, individuals would need to be adept travelers, knowledgeable of a range of environments. Scarlet macaws have been recovered from archaeological contexts throughout the SW/NW. This area spans thousands of square kilometers and a wide range of environments and topographies. The high elevations of the northern Southwest would have offered vastly different sets of challenges from the arid, lower elevation southern Southwest and Mexican northwest. Anyone traveling to the south of Mexico or from the south toward Paquimé would need experience traveling and living in many different, but almost universally arid, environments. Travel during summer months would risk consistent temperatures in excess of 35° C (100° F), while travel during the winter months through the northern Southwest would risk below freezing temperatures and snowstorms. Small- and large-scale droughts are common in Arizona, New Mexico, Sonora, and Chihuahua, meaning that travelers would need to transport large amounts of water or know where to find it during times of scarcity. Requisite knowledge would include a familiarity with consumable local animal and plant species and how to procure them, the ability to find and store water at regular intervals, and knowledge of where one could find safe resting places over the course of the long journey.

Given extensive evidence for trade, migration, and population movement throughout the SW/NW, traveling long distances through harsh environments would not be impossible, but it would require that people leading these trips were knowledgeable travelers or had guides. *Oztomeca* vanguard merchants found success through the possession of "trade secrets" that included knowledge of trade routes and how to create and maintain social contacts needed to obtain goods in distant locales (Hirth 2016:91). Though there are no known pre-Hispanic maps of the SW/NW, knowledge of trails and roads reaches from the present to the pre-Hispanic past (Snead et al. 2009). Knowledge of important Hopi and Pajarito Plateau pathways was passed along in traditions, rituals, songs, and through the experience of traveling across the landscape (Darling and Lewis 2007; Ferguson et al. 2009; Snead 2009). In the absence of maps, repeated performances of songs containing geographical knowledge may have served to navigate long journeys (Darling and Lewis 2007). Roads and trails would have been instrumental in moving people and objects over long-distances and the use of maps, whether material or known, could have assisted in traveling (Hirth 2016:91).

The ability to create and maintain social contacts while traveling would have been necessary. Perhaps the most dangerous part of traveling thousands of kilometers to the south would be the numerous groups of people one would encounter along the way. Hirth

(2016:90) notes that long-distance trade was a risky venture for *oztomeca* merchants that often cost them their lives. Because *oztomeca* merchants traded primarily in highly valued luxury goods and traveled in relatively small groups, threats from non-Aztec communities were a constant concern (Hirth 2016:217-221). Even experienced groups of vanguard merchants with military training, armed guards, and directed by a respected military commander could not defend every potential external threat (Hirth 2016:210) and they were occasionally killed as acts of defiance against the Aztec state (Hirth 2016:220). However, attacking *oztomeca* was considered an attack on the Aztec elite and was a common reason for declaring war against enemies of the state (Hirth 2016:220-221). Individuals or groups of traders from the north seeking scarlet macaws and their feathers and carrying highly valued goods would not have enjoyed this level of protection. Instead, they would have needed to rely on themselves or social connections while traveling long distances. The ability to communicate in many different languages would have been beneficial, if not absolutely necessary. Travel from Veracruz (the northernmost extent of the scarlet macaw's natural habitat) to the SW/NW crosses many distinct languages and language families (Goddard and Sturtevant 1997). Shared language families amongst groups living in these regions may actually have facilitated exchange relationships (Wilcox 1986). It is possible that there was a *lingua franca* that many or all groups spoke, though the nature of such a language is unknown.

What Was it Like to Carry Macaws? Transporting scarlet macaws thousands of kilometers would have been very difficult, but not impossible. Size alone would make the transportation of scarlet macaws quite a challenge, even for experienced bird keepers. Scarlet macaws are among the largest parrots; their bodies can grow to be 84-92 cm (33-

36 in) in length including their long tail feathers with a 112-120 cm (44-47 in) wingspan (Howell and Webb 1995; Iñigo-Elias 2010). The average weight of a scarlet macaw is between 0.9 and 1.2 kg (2-2.5 lbs). Tail feathers are subject to bending and crimping if forced into small spaces. It is unlikely that adult birds could have been kept in a cage for transport; a suitable cage would have to be very large and it is unlikely any available material such as wood or wicker could have withstood a macaw's beak. Fully-grown macaws could very well have sat on a human's shoulders or arm while they traveled, though this would probably limit the number of fully-grown birds one could carry to one or two. Plucking feathers or breaking wings to prevent flying would be one solution to prevent the birds from flying away, but the intentional clipping of feathers prior to fledging can hinder a bird's ability and desire to fly later in life. Alternatively, scarlet macaws can bond with humans—a process that is easiest to achieve when macaws are raised by humans from hatching—which *might* have kept the bird from flying off while traveling. Even when bonded, scarlet macaw keepers attest to occasions in which the birds will fly off, tire, land in a tree or other perch, and become stranded until their keeper finds them (which does not always happen).

Transporters would have fed the birds at regular intervals over the course of the day, and they could have consumed many types of food. Wild scarlet macaws consume a wide range of foods including fruits, seeds, nuts, pods, leaf shoots, flowers, and insects (Abramson 1995e; Iñigo-Elias 2010). Captive scarlet macaws consume an even wider range of food. However, a study by Andrew Somerville and co-authors (2010) found that captive macaws at Paquimé were fed up to 94% maize (*Zea mays*). Debbie Schweikardt (personal communication, 2016) argues that such a diet, rather than the diverse diet of wild macaws, would have caused serious health consequences—such as fatty liver disease—which could result in liver failure and premature death.

Loudness and appearance might also pose challenges for the transportation of scarlet macaws. Bono (2010) notes that scarlet macaw calls have been recorded at 102 decibels (dB) from a distance of 15 feet. For comparison, sustained exposure to 90-95 decibels may result in damage to the ear, hand drills measure at 98 dB, motorcycles have a loudness of about 100 dB, and power saws from 3 feet away are measured at 110 dB (Chasin n.d.). A lone bird is unlikely to call often, but multiple birds often call back and forth, especially if separated from one another. For the purposes of individuals transporting macaws, the loud calling of scarlet macaws would pose a clear concern for anyone attempting to travel inconspicuously. The bright red, blue, and yellow coloration of the scarlet macaw would also stand out against the desert and wooded environments of the SW/NW. The sounds and colors of macaws could be either a positive or a negative attribute for their human carriers, depending on the nature of their journey. A tradesperson might embrace this attention given an ultimate goal of exchanging macaws, while one attempting to bring back a macaw as a symbol of distant, ritual power might prefer to travel furtively. The ability of scarlet macaws to repeat spoken phrases might have been a revelation in passing, especially to people who associated the scarlet macaw with deities relating to agriculture, fertility, and the sun (McKusick 2001; Tyler 1991). Scarlet macaws are much easier to teach phrases while young, and long journeys with birds might have been opportunities to train scarlet macaws to repeat specific phrases.

A further challenge is the generally noncompliant temperament of scarlet macaws. While all birds have unique personalities, scarlet macaws are among the most noncompliant of all macaws and parrots (Debbie Schweikardt, personal communication, 2016). While captive birds tend to become less aggressive over time, scarlet macaws remain difficult to train and can be unwilling to follow directions, a sentiment echoed in online macaw training forums. Bonding with scarlet macaws is possible for humans, but it requires that the birds be well taken care of through an adequate diet and large amounts of attention (Iñigo-Elias 2010). Even when bonded, human caretakers are likely to encounter bites and scratches from the remarkably strong beaks and talons of scarlet macaws, especially when the birds are responding to unfamiliar stimuli. In pounds per square inch (psi), a scarlet macaw beak is capable of levels between 500 and 700 (Rolfe 2017). For comparison, that is stronger than the bite of a human (~160 psi), English Mastiff (~550 psi), and lion (~650 psi) (Hill 2019). Scarlet macaws placed in any kind of basket could easily break through it. They are intelligent animals that enjoy puzzles; a behavior often manifested in the birds learning how to release door mechanisms on metal modern-day cages. In terms of human experiences, the hands and arms of the individuals transporting these birds were likely cut and scratched from continuous interaction. Burden baskets or other bags were likely to have been chewed on and damaged throughout the travel, even if the transporters also carried materials or objects for the birds to chew on (a practice that is suggested today). Scarlet macaws that have bonded with humans are content to sit on the shoulders or head of the individual and will often preen their hair, as they would the feathers of a mate. As a result, pre-Hispanic transporters traveling with bonded macaws might also have fairly unkempt hair or clothes as the birds picked at them while traveling.

Some of the above challenges associated with adult macaws could be mitigated by transporting live hatchling (1-3w) or nestling (3-11w) scarlet macaws (Figure 3). This observation has also been made by Gilman et al. (2014; 2019), who find that an adult macaw's aggressive temperament would have been challenging to deal with over a long journey. Prior to fledging, scarlet macaws lack the bright, distinctive coloration of their adult counterparts and will generally be much quieter and more docile (Debbie Schweikardt, personal communication, 2016). Because they lack full adult plumage, they would not be capable of flying away. Charmion McKusick (1974:276) notes the dangers of respiratory infections at young ages and the drain on the birds' immune systems as they fledge. She argues that transportation would be easiest after they fledge at around eight weeks, though our experience is that the birds will fledge very near 90 days in the wild and in captivity (McKusick 1974:276). Scarlet macaws typically lay eggs between December and March every one to three years (Abramson et al. 1995; Crown 2016), so the time of procurement and transportation would occur prior to the rainy season (July-September) in the south and before the hottest parts of the summer in the warmer SW/NW (June-August). Depictions of humans and birds on Mimbres Classic Period Black-on-White vessels (Figure 4) excavated from Mimbres settlements in southwestern New Mexico may offer some evidence that macaws were transported at a young age (Gilman et al. 2014).

Traveling with hatchling or nestling scarlet macaws would also present substantial challenges. Hatchlings would require a transporter to feed them as frequently as every 30 minutes, while nestling macaws would have to be fed 4-5 times/day or more. Like adult macaws they could eat a wide range of foods, so long as they were small enough to pass

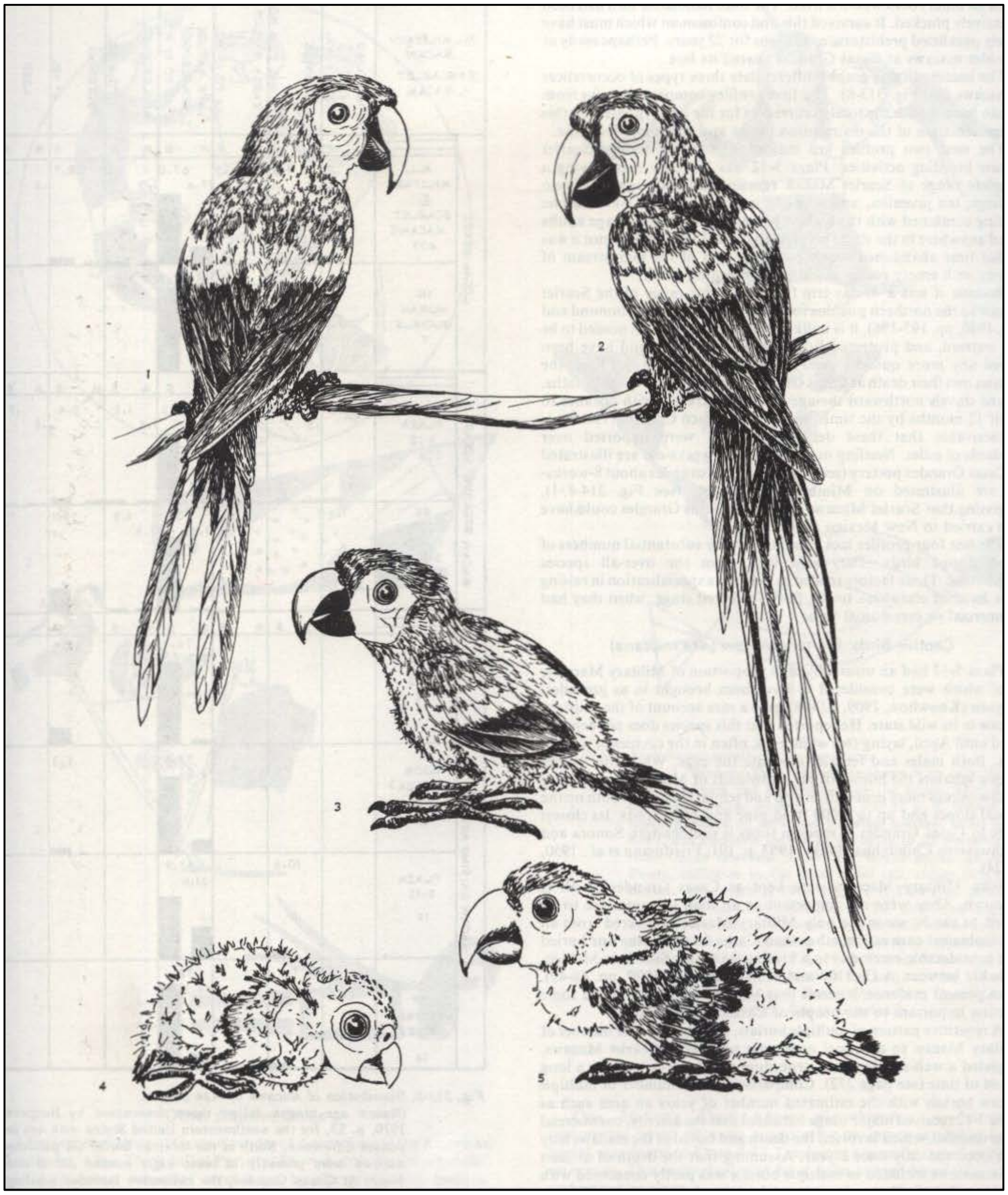


Figure 3. Age stages of the scarlet macaw (from McKusick 1974:277). 1: Immature (4-11 mo.), 2: Newfledged and older (>12 mo.), 3: Juvenile (seven to eight weeks), 4: Nestling (four weeks), 5: Nestling (six weeks).

Figure 4. Mimbres Classic period bowls depicting birds, their transporters, and burden baskets from: A: Unprovenienced, B: Mattocks Site, C: Galaz, D: Galaz. Images courtesy of MimPIDD.

through the birds' small throats. Hatchling and nestling macaws get all of their water from regurgitated foods (in the wild) or formulas (in captivity). Macaws in captivity today typically do not have water incorporated into their diets until as early as five to seven weeks and as late as four to six months. It is possible that human transporters could have fed hatchling or nestling macaws regurgitated food with considerable effort. Furthermore, feeding from a human mouth would limit the amount of water the birds received and could also have had adverse effects on the birds' health through the introduction of foreign bacteria. Transporters would also want to keep the birds at or around 40° C (104° F), which is the normal body temperature of hatchling-nestling macaws (Gilman et al. 2014:102). Prior to fledging, young macaws cannot regulate body temperature on their own (Abramson 1995f). Given the warm spring and summer temperatures of the regions through which the macaws were transported, body temperature regulation could have been achieved by wrapping the birds in clothing or blankets and keeping them on the body of the transporter. Failure to provide enough warmth and adequate nutrition for the hatchlings or nestlings would have had particularly adverse health effects or resulted in their death, as they would not be as resilient as adult macaws. Despite many dangers, young macaws are relatively hardy and when handled with knowledge of their care, they could be transported over long distances without obvious health- or stress-related problems.

Eggs that were taken from the nest of scarlet macaws could also have been transported, though this would maintain its own set of challenges. The amount of eggs and the fertility of eggs laid by macaws varies based how long a breeding pair have been together (Abramson 1995d:171). In the first year of egg producing, clutches may contain one to two eggs, both of which could be infertile. As the pair matures, the birds can lay up to four eggs, all of which can be fertile. Candling—holding a light up to an egg to check on its developmental progress—can help determine whether eggs are fertile or infertile, but can be harmful to the eggs (Abramson 1995d:172). Caretakers would need to maintain warm temperatures (between 37.2° C and 37.4° C [99.0° F to 99.3° F], under optimal conditions) and relatively high levels of humidity (50 to 55%) (Abramson 1995d:176). In the wild, adult birds do this by bathing themselves often and sitting on the eggs. In captive environments where adult macaws are not allowed to rear the eggs, incubators are often used (Abramson 1995d). Macaw eggs hatch after 25-30 days, which would have allowed transporters to make a relatively long journey (Malville 2001) without having to provide additional food or water. Finally, eggs are incredibly fragile and the potential for destruction while traveling would be very high.

Raising Scarlet Macaws

Given the extensive evidence of macaw raising at Paquimé (Di Peso et al. 1974; Minnis et al. 1993; Somerville et al. 2010; Chapter 3), we draw on characteristics (e.g., architecture, availability of resources) of this settlement as an example for the contexts in which macaws could have been raised in the SW/NW. The remains of more than 300 scarlet macaws were recorded by Di Peso and co-authors (1974) in their partial excavation of Paquimé. The birds were primarily spread throughout plaza, room, and burial contexts. Plazas 3-11 (House of the Serpent), 3-12 (House of the Macaws), and to a lesser extent, Plaza 6-12 (House of the Macaws) contained what Di Peso and co-authors (1974) termed “nesting boxes” where macaw keepers facilitated breeding of the birds

(Figure 5). Macaw remains were recovered from all three plazas, but the vast majority came from Plaza 3-12, where macaw remains were scattered throughout the plaza. Macaw remains were found in room contexts, primarily from Rooms 36-11 and 38-11 (House of the Macaws), but were also recovered throughout the settlement. Below, we draw on these contexts at Paquimé to point out the challenges associated with raising and breeding macaws in the NW/SW and explore what this process would have been like for the birds' keepers.

What Was it Like to Raise Scarlet Macaws?

Where Were they Kept? The many challenges associated with transporting scarlet macaws are mirrored in the requirements to successfully raise them far from their neotropical homeland. Like with transporting macaws, inhabitants of the SW/NW would

Figure 5. Reconstructed adobe macaw "nesting boxes" from the site of Paquimé. Circular "cage stones" and stone plugs are seen in the bottom right, enclosing the cage. Photo by author.

have needed somewhere to keep the birds that prevented them from flying away and/or kept them safe from local predators, which probably included dogs, coyotes, wolves, snakes, raptors, and cougars. Modern minimum cage requirements for scarlet macaws are 75 cm wide x 75 cm deep x 150 cm tall (appx. 30 x 30 x 60 inches), though sources recommend something twice as large (Abramson 1995c). Most large macaw cages are stainless-steel, given the strength of the macaw's beak and their tendency to chew on the cage bars and use of the beak to move around. Macaw "nesting boxes" discovered at Paquimé were adobe pens 50 cm wide x 100 cm deep x 50 cm tall (appx. 20 x 40 x 20 in) and topped by *petate* woven fiber matting (Di Peso 1974). The adobe pens contained a large hole with removeable circular stone rings and plugs in the front to give keepers access to the birds (McKusick 1974:269). At 82-94 cm long with a wingspan of 112-120 cm, a single, fully-grown scarlet macaw would have been a tight fit in these pens and unable to completely spread its wings (Abramson 1995c). It is true that scarlet macaws prefer small, safe spaces for breeding (Abramson 1995b), but it might have been a challenge even to fit two full-sized birds in enclosures so small. If fully-grown macaws were regularly kept in these enclosures, they would have very little space to move around or even preen themselves. This would have given them a noticeably unkempt appearance and perhaps more importantly, it might result in the bending and possible breaking of their feathers. This might have been problematic for Paquimé's inhabitants, for whom feather exchange was likely a central component of their economy (Somerville et al. 2010).

Contemporary macaw keepers will keep young (i.e., neonates, nestling, or fledging) in plastic bins of a similar shape and size to the macaw pens found at Paquimé.

Once their long tail-feathers are fully grown at around six months, they are typically relocated to a larger cage. Before that time, they move the birds out of these small cages during the day so that they can learn through interaction with their environments and—if wanted—spread their newly-feathered wings and attempt very brief flights. It is impossible to say how much time Paquimé's scarlet macaws spent in the adobe pens, but if they were kept in adobe pens all day long, it would have had physical and psychological impacts on the birds, as we discuss below. Young macaws in captivity are remarkably social and can be left to interact with other birds and humans (Abramson 1995f).

Keeping older (6+ mo) scarlet macaws in small enclosures outside of their natural habitat would have a noticeable impact on their behavior. Like other birds, scarlet macaws experience displaced behaviors when removed from their natural environment. Instinctual behaviors like preening mates, chewing on hard foods like nuts, and flying become impossible in captivity and lead macaws to act in unnatural or even harmful ways. Captive macaws, especially those that are kept alone and/or refused mentally and physically stimulating activities (e.g., playing with toys, flying), can act in ways that are harmful to themselves or their keepers. We noted above that in the absence of a mate, macaws will preen themselves and their keepers; this is a necessary behavior to remove the sheathing around feathers. Captive macaws occasionally preen to the point of removing a feather or damaging the feather follicle. Scarlet macaws in captivity will also bite or chew on their surroundings constantly and use their beaks to move around. These behaviors are not typically problematic in contemporary metal cages where macaw keepers provide wood and other things to chew on, but it would have posed challenges in small adobe pens covered with *petate*. Their strong bite and constant chewing would easily have taken apart the woven matting and eventually the adobe pen walls.

It is also possible that, when they were able, Paquimé's scarlet macaw population was permitted to fly. Though letting the birds fly freely may seem at odds with the great care afforded to importing them, it might have important implications for the health of the birds and for how many birds were actually at the site. Once they fledge, wild scarlet macaws begin to hone behaviors associated with flying (e.g., mechanics, predator evasion) and eventually fly alongside their parents. In captivity, scarlet macaws can be taught to fly—and return to a specific person or locale—during this phase, if given adequate space to do so. Archaeologists working within the natural range of scarlet macaws in southern Mexico report that the birds will spend the day in the treetops and return to locations where they can access human-made foods at certain points in the day (Joel Palka, personal communication, 2019). Permitting the macaws to fly freely would minimize displaced behaviors and allow access to sunlight. It is possible that macaws could find edible foods in the surrounding region (e.g., acorns, pine nuts, fleshy fruits), but the landscape would be very different from their natural habitat (Minnis and Whalen 2015b). This would subject macaws to the harsh, desert environment of northern Chihuahua and local predators. If the birds flew, Paquimé's scarlet macaws could have been killed in the surrounding deserts and outside the limits of the settlement itself. Paquimé—the largest settlement for hundreds of kilometers and a center that imported many non-local goods—would have appeared even more intriguing with a cloud of scarlet macaws flying overhead.

What Did it Sound Like? Paquimé's scarlet macaw population would have ensured that it was a very loud place to live. We note above just how loud a single macaw can get, and Di Peso et al. (1974) estimate that at any given time Paquimé could have housed up to 25 macaws. Macaws vocalize loudest in the mornings and evenings and the calling in unison of up to 25 birds would have rung throughout the settlement. Distressed scarlet macaws can call all day, which might also have had quite an impact on Paquimé's inhabitants. If trained while young, scarlet macaws can become particularly adept at repeating human-spoken words, phrases, and sounds. Birds in captivity are often trained to repeat specific phrases and will also pick up on sounds that they enjoy or sounds associated with actions they enjoy. If trained, they can repeat phrases or actions (e.g., wave, high five) on command, and they will even associate sounds with actions (e.g., saying goodbye when their keeper leaves them). People living with macaws at Paquimé likely knew of these abilities and macaw keepers may even have taught these birds phrases and actions of significance to local people.

What Were they Fed? Scarlet macaws at Paquimé occupied a place of such importance that they were afforded foods cultivated for humans. Andrew Somerville and co-authors (2010) found that a sample of 30 scarlet macaws from Paquimé were fed primarily C_4 photosynthesizing plants, consistent with a diet composed primarily of maize. Minnis and Whalen (2015) note that in addition to maize, squashes (*Cucurbita* sp.), gourds (*Lagenaria siceraria*), and beans (*Phaseolus vulgaris*) were also grown in the Rio Casas Grandes floodplain. Local plants such as prickly pear fruits and pads (*Opuntia* sp.), acorns (*Quercus* sp.), pine nuts (*Pinus cembroides*), juniper berries (*Juniperus* sp.), and seeds from goosefoot (*Chenopodium* sp.), pigweed (*Amaranthus* sp.), and purslane (*Portulaca* sp.) were also available (Minnis and Whalen 2015b). Together, this variety of plants, fruits, and seeds would constitute a healthy diet—similar to pellets and diets that macaws are fed in captivity. Macaws would also require water, which was available seasonally from the Rio Casas Grandes and in numerous reservoirs at and around Paquimé. In the wild, regular bathing serves to keep their wings clean for flight and captive, non-flying macaws living in desert environments today will drink ample water, regularly bathe themselves, and play in water. Keepers at Paquimé could have facilitated this by pouring water over the adobe pens and regularly providing water for the birds to drink and bathe in.

Who Would Have Cared for the Macaws?

For scarlet macaws to thrive in the SW/NW, the individual(s) caring for scarlet macaws would have had to have been very knowledgeable about macaw behavior and biology. The depth of knowledge required for macaw husbandry and burials of humans with multiple macaws in plaza contexts where macaw remains are abundant suggest that specific individuals were responsible for macaw keeping (Di Peso et al. 1974). The quantity of people responsible for raising macaws will have important implications for how they interact with humans later in life. We mentioned above that it is easier to raise macaws when they are bonded with a single person, but multiple individuals could also have cared for the macaw population at Paquimé (as is common at bird stores). When young scarlet macaws are tended to by multiple people, they will not attack people with whom they are unfamiliar. If birds are raised by many people, they will tend to be more comfortable in open social environments with groups. Alternatively, birds raised by one person may become strongly bonded to that individual and react negatively if confronted by unfamiliar people. The ability to influence how macaws behaved, or to have had macaws respond to verbal statements would have had important implications for how an individual or group of individuals were perceived by their peers in the past.

One aspect of parrot-human interaction that has yet to be addressed in the literature is psittacosis—the zoonotic infectious disease often observed in members of the *Psittacine* order. Psittacosis is caused by the bacterium *Chlamydophila psittaci*, which can be transmitted through the feces and nasal discharge of infected birds (Hammerschlag and Kumar 2008:625). Once infected, parrots can transmit the disease to other birds (including turkeys, ducks, pigeons) and also to humans (Goldstein and Abrahamian 2017). Birds affected by psittacosis may be asymptomatic, or experience a range of symptoms including anorexia, lethargy, and watery green droppings (Hammerschlag and Kumar 2008:625). Humans with psittacosis will experience an incubation period, followed by cough, high fever, diarrhea, joint pain, and if untreated, spleen enlargement, severe headaches, respiratory infection, liver and heart inflammation, and even death (Marrie 2011:321; Hammerschlag and Kumar 2008:625). Though there were over 900 cases of psittacosis reported worldwide between 1988 and 2003, it has decreased in recent years to about ten per year (Hammerschlag and Kumar 2008).

Given the risk of psittacosis amongst contemporary bird keepers and genetic evidence to suggest a pre-Hispanic origin for the disease, it is likely that Paquimé's macaw keepers saw psittacosis affect their macaw population and possibly even their own health. Read and co-authors (2013:7) sequenced 20 North American strains of *C. psittaci* and found that the bacterium likely originated in the New World prior to 1500 CE. Marrie (2011) states that between 5-8% of individuals in bird populations are carriers, but this may increase to 100% when birds are subjected to stresses associated with shipping, crowding, and breeding, all of which may have been part of daily life at Paquimé. Turkeys, which also number in the hundreds at Paquimé (McKusick 1974), are also carriers for psittacosis, and their presence would have increased susceptibility of the birds and their caretakers. The Center for Disease Control reports that prior to antimicrobial agents, respiratory infections with Chlamydial infections killed 15-20% of affected humans (Balsamo et al. 2017). The presence of psittacosis in the SW/NW would have posed a unique and substantial threat to Paquimé's population of macaws and turkeys, as well as their human caretakers.

Were Macaws Bred at Paquimé?

A number of studies into scarlet macaws recovered from archaeological contexts in the SW/NW have asserted that macaws were bred outside of their natural habitat (Di Peso et al. 1974; Gilman et al. 2014; 2019; Minnis et al. 1993; Rizo 1998; Somerville et al. 2010; Whittlesey and Reid 2013; c.f. Crown 2016). Most of these studies suggest Paquimé as the post-1250 CE breeding center that supplied much of the SW/NW with scarlet macaws. Multiple lines of evidence substantiate claims of macaw breeding at Paquimé: The presence of hundreds of macaws (McKusick 1974), abode pens for keeping the birds (Di Peso et al. 1974), an instance of eggshells recovered from the adobe pens (McKusick 1974:281), the recovery of breeding aged birds (McKusick 1974), and isotopic evidence suggesting that scarlet macaws were fed primarily maize, which is atypical in wild macaw diet (Somerville et al. 2010).

However, several concerns regarding whether scarlet macaws were bred at Paquimé still need to be addressed. First, Paquimé's breeding-aged (4+ yr) scarlet macaw population was remarkably small, with elements from 36 birds, or only 11.2% of the total scarlet macaw population (McKusick 1974). The dearth of older macaws may be a result of ritual prescriptions mandating the sacrifice of young birds as some have suggested (McKusick 1974; Whittlesey and Reid 2013) as well as the harsh environment and poor care the birds received at Paquimé. Second, it is nearly impossible to distinguish male from female scarlet macaws without observing sex-specific behavior (e.g., laying eggs) or through genetic testing (Abramson 1995a; Crown 2016). Human residents of Paquimé would not have been able to identify female macaws—and select them for breeding—until the birds reached reproductive maturity at four years of age. Third, reproductively mature female macaws may lay unfertilized eggs, so the presence of eggshell is not conclusive evidence of breeding (Crown 2016). Fourth, scarlet macaw health has an impact on reproductive success. Given the many challenges associated with keeping scarlet macaws physically and psychologically healthy at Paquimé, ensuring the birds were healthy enough to breed would have been a challenge. McKusick's (1974) paleopathological analysis of scarlet macaw bones from Paquimé found that 284 bones displayed a range of pathologies[1] including fractures, warping, accretions, ulnar roughening, abnormal bone fusion, abscesses, and tumors. She suggests that the birds probably experienced reactionary attacks from their keepers, bites from other birds, lack of sunlight (Vitamin D), lack of calcium, and "improper" diet (McKusick 1974:280-281). The prevalence of bone pathologies suggests that the conditions in which the birds lived were probably quite damaging to the birds, which would have made it difficult for them

[1] Charmion McKusick (1974:274) does not report total bone counts, but the 284 bones displaying pathologies come from a total population of 503 individual macaws. For comparison, in Paquimé's population of 344 turkeys, only 43 pathologies were observed.

to breed. Finally, the successful bonding of two birds required for breeding would ensure that relationships between these macaws and their keepers were very challenging. Scarlet macaws often bond with a mate for life and when paired for breeding in captivity they become very aggressive toward anyone that attempts to interact with them, including humans with whom they were previously close and other birds. This would have made attempts to handle the birds very dangerous during the process of breeding and anytime thereafter.

We do not definitively conclude that pre-Hispanic people could not have successfully bred scarlet macaws in the SW/NW. However, we do question some of the lines of evidence frequently cited from Paquimé. Additional research into macaw genetics and behaviors, as was done by Richard George and co-authors (2018), Patricia Crown (2016) will provide greater insights into multifaceted interactions amongst past humans and scarlet macaws.

Conclusions

The above discussion highlights the many challenges and potential solutions to transporting and raising scarlet macaws in the SW/NW. We find that, though it would have been difficult transporting, raising, and breeding scarlet macaws outside of their natural habitat, it would not have been impossible. Indeed, resources and practices employed in contemporary macaw husbandry were used or constructed by past people. Traveling thousands of kilometers from the natural range of scarlet macaws would have been a challenging journey for both humans—whether traveling merchants or individuals in search of esoteric knowledge and prestige—and the macaws that traveled with them.

At times the birds could have been loud, noncompliant, aggressive, and required care at many points throughout the journey. We agree with Patricia Gilman and co-authors' (2014; 2019) suggestion that humans probably selected hatchling or nestling macaws for their small size and docile nature. If they reached the SW/NW alive, it would have been equally difficult for humans to care for the macaws as they grew. Few macaws reached one year of age at Paquimé, which is not surprising given prevalent bone pathologies suggestive of disease, attacks from humans or other birds, poor diet, and lack of sunlight (McKusick 1974; Somerville et al. 2010). The poor health of Paquimé's scarlet macaw population may also have led to widespread psittacosis, which would have introduced infectious disease into the human population. Recent studies suggested breeding of macaws in the SW/NW began as early as 900 CE (George et al. 2018; Somerville et al. 2010). Though macaw breeding would have been possible in the SW/NW, we challenge some of the oft-cited indicators of breeding and suggest that the process might not have been so straightforward.

Ultimately, this chapter highlights the multifaceted relevance of scarlet macaws for the study of past humans. We have long been captivated by animals that figure into mythologies, diets, research agendas, workplaces, and even our own homes. Scarlet macaws at settlements in the SW/NW were a part of all aspects of life, including long-distance exchange and economics, religious practice and belief systems, and changes in social complexity and inequality, all of which influenced how people experienced daily life. Highlighting the varied interactions between humans and macaws adds nuance to our understanding of daily life in the past.

Chapter 3:

INVESTIGATING PRE-HISPANIC SCARLET MACAW KEEPING THROUGH RADIOGENIC STRONTIUM ISOTOPE ANALYSIS AT PAQUIMÉ IN CHIHUAHUA, MEXICO

Christopher W. Schwartz

Scarlet macaws (*Ara macao*) were and continue to be highly valued for their ritual, economic, and political roles amongst pre-Hispanic and contemporary peoples of the United States Southwest and Northwest Mexico (SW/NW). They were prized for their brilliant multi-colored feathers (Figure 6A) and imbued with ideological significance throughout their endemic range—from Central America north to Mexico's Gulf Coast (Guernsey 2006; Rizo 1998; Tedlock 1985). For almost 3,000 years, scarlet macaws figured prominently into Mesoamerican creation myths and cosmology (Freidel et al. 1993; Guernsey 2006; Tedlock 1985), ceremonial attire and paraphernalia (Rizo 1998), and iconographic depictions seen on structures, stelae, and ceramics (Fash 1991; Rizo 1998). Interestingly, as one moves north from Central America toward the SW/NW and out of the scarlet macaw's natural habitat, the birds appear to increase in abundance and ideological significance at archaeological sites (McKusick 1974; Vokes and Gregory 2007). Today, they continue to be significant to ancestral communities living in the SW/NW, as evinced through the roles of macaws in traditional histories, the use of macaw feathers in rituals and ceremonies, and the continued macaw and parrot clan traditions in Hopi and Zuni communities (Whiteley 2021).

Between 1150 and 1450 CE, the ceremonial center of Paquimé in Chihuahua, Mexico served as a regional locus of long-distance exchange in the SW/NW. Among other exotic and non-local materials such as copper ornaments, marine shell, and turquoise, scarlet macaws appear to be one of the major imported materials discovered at Paquimé (Whalen 2013). Despite a distance of at least 1,000 km from the northernmost extension of their natural habitat (Figure 6B), over 300 scarlet macaws (and over 500 macaws in total) were unearthed at the site (McKusick 1974). This is the largest collection of macaws yet discovered at an archaeological site. The number of scarlet

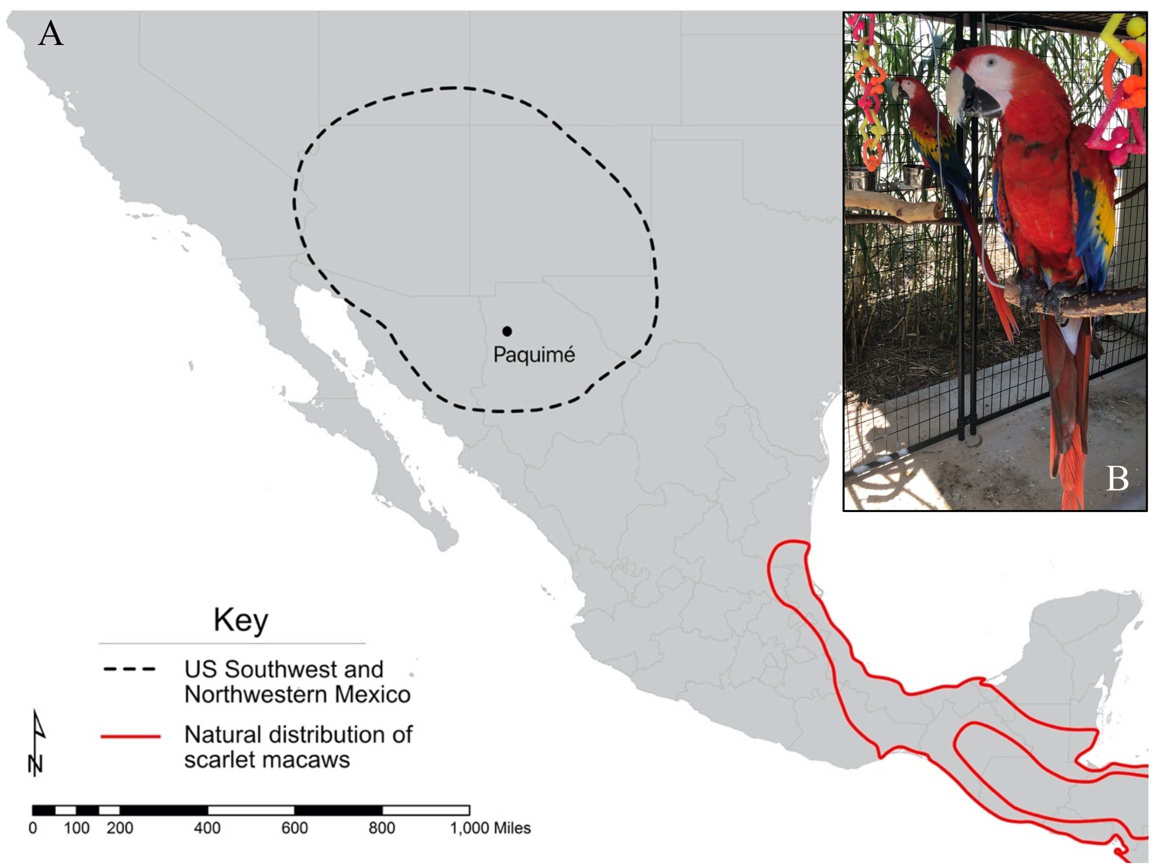


Figure 6. (A) Scarlet macaw (*Ara macao*) distribution in North America. (B) Photo of scarlet macaw inset. Photo by author.

macaws at Paquimé raises important questions about the relationship between Mesoamerica and the SW/NW. What was the significance of scarlet macaws for the pre-Hispanic inhabitants of Paquimé? Were the macaws raised at the site or systematically imported over long distances? Was Paquimé's scarlet macaw population self-sustained or continuously supplemented with birds from their endemic homeland in the neotropics of southern Mexico and Central America?

The large quantities of macaws, the presence of small amounts of macaw eggshell, and the nesting and breeding boxes with cage stones recovered from Paquimé and surrounding settlements suggest that these birds were being raised locally, perhaps to meet demand amongst Southwestern societies to the north (McKusick 1974; Minnis et al. 1993). A prior study by Somerville et al. (2010) that examined carbon and oxygen isotopes in archaeological macaw bone found that while most scarlet macaws appeared to have been raised locally and fed largely C_4 plants (e.g., maize [*Zea mays*]), a couple outlying specimens suggested that macaw breeders at the site likely maintained exchange ties with source areas. Finally, a study of scarlet macaw ancient DNA by George et al. (2018) suggested that a pre-1250 CE breeding colony of scarlet macaws existed in the SW/NW. Overall, these studies begin to illustrate the complexity of pre-Hispanic macaw procurement and knowledge allocated to their care in the SW/NW.

This study examines a subset of scarlet macaws excavated at Paquimé to shed further light on the extent to which the inhabitants of Paquimé were reliant on direct exchange with or acquisition from Mesoamerican peoples to the south, or whether they locally raised scarlet macaws in large quantities within the Casas Grandes region to supply other parts of the SW/NW with ritually, economically, and politically valuable macaws and their feathers. Specifically, it builds on prior investigations of scarlet macaw keeping at Paquimé through the first use of radiogenic strontium isotope analysis to explore whether non-local scarlet macaws recovered far from their endemic habitat were acquired through transport over long-distances or the result of a large-scale avicultural program designed and implemented at Paquimé. This study provides new information about the extent to which pre-Hispanic inhabitants of the SW/NW interacted with people in eastern and southern parts of Mesoamerica and how rare, non-local objects were acquired and used in the development of Paquimé as a regional center. The results suggest that Paquimé's scarlet macaw population was primarily raised locally—both at Paquimé and within the larger Casas Grandes region—and support the presence of other scarlet macaw populations within the SW/NW from which Paquimé received birds, as is suggested by George et al. (2018). These data suggest a diversification of breeding locations to ensure adequate macaw populations and attest to the complexity of pre-Hispanic exchange practices in North America.

Interregional Interaction

The degree of interactivity inherent in the suite of ideas, objects, and architectural and iconographic styles that moved between Mesoamerica, West Mexico, and the SW/NW has been a source of long-standing debate. Early hypotheses suggested that Mesoamerican *pochteca* traders directly contacted and dominated Southwestern groups (Di Peso et al. 1974; Kelley and Kelley 1975), while others have suggested local development that made use of rare, non-local ideas and materials (McGuire 1980). Regardless of how this interaction arose, studies of materials like cacao (*Theobroma* *cacao*) (Crown 2018; Crown and Hurst 2009; Mathiowetz 2018), copper bells (Hosler 1994; Vargas 1995, 2001), and scarlet macaws (Crown 2016; Gilman et al. 2014, 2019; Somerville et al. 2010;), and architecture such as ballcourts (Harmon 2006; Wilcox 1991) have made clear that material and ideological interaction occurred between these macro-regions. However, the means through which these objects and ideas reached the SW/NW remain elusive.

Recent studies have added complexity to this debate by using chemical and biogeochemical techniques to challenge exchange patterns that were previously thought to be well-understood. Large quantities of turquoise found at archaeological sites throughout the SW/NW led researchers to suggest that turquoise recovered in parts of Mesoamerica may have been mined in the SW/NW (Harbottle and Weigand 1992; Weigand 2008; Weigand et al. 1977). This argument was based on the fact that most known turquoise mines are located in the SW/NW, meaning that rare, specialized objects, such as copper bells and shell trumpets, could have been traded northward in exchange for locally-mined SW/NW turquoise. Analysis of radiogenic strontium ($^{87}Sr/^{86}Sr$) and lead ($^{206}Pb/^{204}$) isotopes in turquoise mosaic tiles recovered from Mesoamerican sites by Thibodeau et al. (2018) found that none of the sampled tiles matched known turquoise deposits from the SW/NW. Because of the relatively low $^{87}Sr/^{86}Sr$ values of the sampled tiles, the authors concluded that a source location south of the SW/NW was most likely, meaning that much of this mined turquoise may actually originate in Mexico.

Unlike other materials and architectural styles moving between Mesoamerica and the SW/NW, scarlet macaws were once animate, living animals. Thus, their skeletal remains provide an important means of studying the exchange practices of pre-Hispanic societies. Studies of bone pathologies and depositional practices (Crown 2016; Hargrave 1970; McKusick 1974; Whittlesey and Reid 2013) have illuminated the diverse behavioral practices surrounding the treatment of macaws in the SW/NW. Studies using biogeochemistry (Somerville et al. 2010) and ancient DNA (Bullock and Cooper 2002; George et al. 2018) have illuminated the diet, environmental conditions, and potential genetic points of origin for these birds. Radiogenic strontium holds the potential to illuminate macaw keeping practices of pre-Hispanic populations by informing whether macaws found in the SW/NW were raised in this region or acquired from distant source areas. To understand the implications of biogeochemical studies of the scarlet macaw, we will first contextualize the significance of these birds in the SW/NW.

Scarlet Macaws and Paquimé

At no archaeological settlement were scarlet macaws more ubiquitous than Paquimé in modern-day northern Chihuahua. Given its intermediary location and importance as a regional center, Paquimé has often been situated at the center of discussions of Mesoamerican-SW/NW interactions. Located in the Casas Grandes region of northwestern Chihuahua, Paquimé emerged as a regional center during the Medio period, dating between 1150/1200 and 1450 CE (Phillips and Gamboa 2015). This florescence involved the construction of Mesoamerican-style ballcourts and platform mounds, as well as the importation of hundreds of copper ornaments, turquoise pieces, scarlet macaws, and millions of pieces of marine shell (Rakita and Cruz 2015; Whalen 2013). Birds and their byproducts appear to have been quite important to the inhabitants of Paquimé, as evidenced by the discovery of many avian species in excavations throughout the site (McKusick 1974; Somerville et al. 2010). Among these species, macaws and common turkeys (*Meleagris gallopavo*) were most abundant (McKusick 1974). Excavations at the site revealed the presence of 503 macaws, including scarlet macaws, military macaws (*Ara militaris*), and indeterminate macaws (*Ara sp.*). The majority of these birds were scarlet macaws (n = 322), which is a pattern common to other parts of the SW/NW despite the fact that the natural range of military macaws spans into northern Mexico and would require less travel to procure (McKusick 1974). Given that this quantity is more than the total of all scarlet macaws that have been discovered in archaeological contexts north of the Casas Grandes region (n = 144 as per Hargrave [1970], and just over 200 in a survey of more recent literature by the author), researchers have suggested that Paquimé likely controlled and supplied the exchange of macaws in the SW/NW (Minnis et al. 1993).

There is extensive evidence for the keeping of macaws at Paquimé. Up to 56 small, rectangular adobe nesting and breeding boxes oftentimes associated with a donut-shaped cage stone were used to tend to large quantities of birds (Figure 7) (Minnis et al. 1993; Somerville et al. 2010; but see Chapter 2 for the challenges of keeping fully grown scarlet macaws in Paquimé's adobe pens). Breeding-age birds were discovered at the site and in the surrounding region by Whalen and Minnis (2001c), who suggested that their presence was evidence for intermediate level complexity for the Paquimé regional system, where kin or elite groups could have competed for social power through the manipulation of networks of prestige goods exchange. In contrast to a single powerful group, the

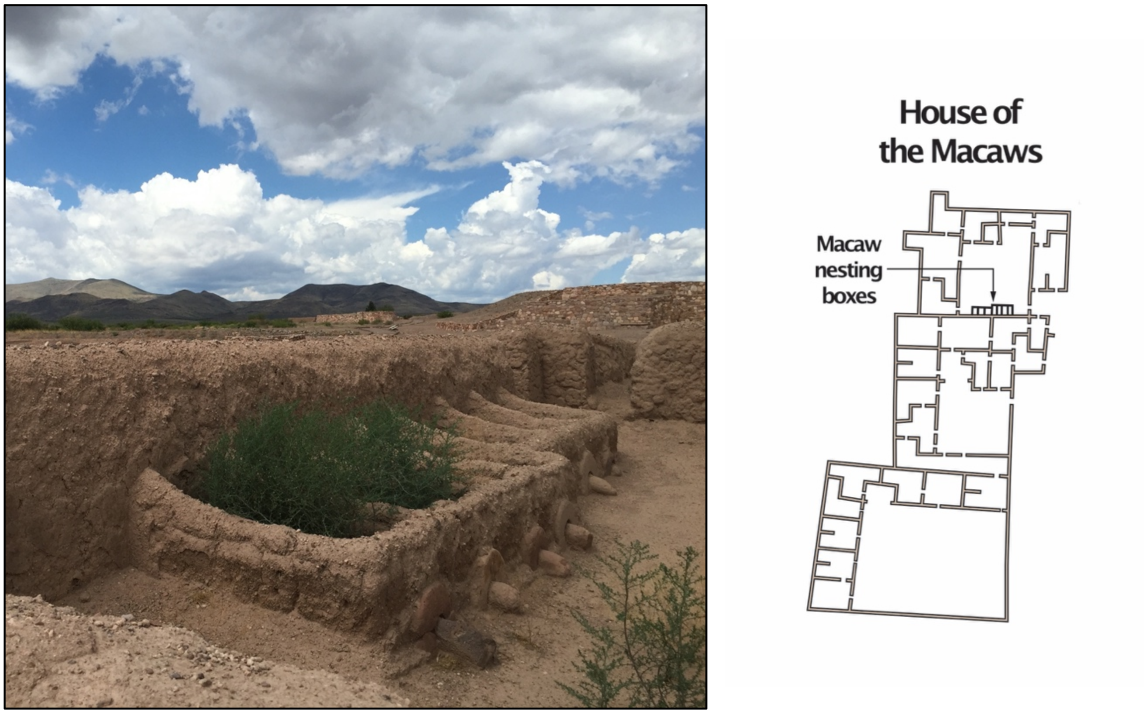


Figure 7. Reconstructed adobe macaw pens from the site of Paquimé with map of location adapted from Ure and Searcy (2016). Circular “cage stones” and stone plugs are seen in the bottom right, enclosing the cage. Photo by author.

extensive acquisition, production, and exchange of prestige objects at Paquimé would have been mediated by elites that could gain and lose power over time.

It seems clear that macaws and their feathers would have been prestigious and valuable sources of social power to the inhabitants of Paquimé, but age-related patterns in deposition suggest an additional ideological value. Ethnohistoric evidence (Alcalá 2008; Berdan 2006 cited in Nelson et al. 2021; Mongne 2019; Nelson et al. 2021; Rizo 1998; Sahagún 2001) for feather exchange in greater Mesoamerica suggests that demand for macaw feathers was a likely reason for trade and keeping of macaws at Paquimé, though no archaeological examples of macaw feathers were recovered from Paquimé (Di Peso et al. 1974). Aztec leaders exacted tribute to the capitals of the empire in the form of the scarlet macaw's long tail feathers, which were utilized in ceremonial attire and paraphernalia (Guernsey 2006). Scarlet macaws also figured prominently into Mesoamerican worldview as elements of iconography, architecture, and as important mythic personages (Rizo 1998). However, no known Mesoamerican examples exist for the intentional deposition of scarlet macaws seen extensively at Paquimé and elsewhere in the SW/NW. Though breeding-age macaws were found at Paquimé, almost 90% of scarlet macaws did not survive past ten months (McKusick 1974), and this pattern is mirrored in the SW/NW where few breeding age birds have been recovered (Creel and McKusick 1994; Hargrave 1970; McKusick 1982; Olsen 1990; Ruble 1996; Whittlesey and Reid 2013; Wyckoff 2009; but see Crown 2016 for a critique of Hargrave's morphological aging of scarlet macaws). This pattern challenges the assumption that macaws were imported exclusively for their feathers, given that macaws can live to be up to 60 years old and living birds would continue to naturally shed feathers throughout their lifetime (Abramson et al. 1995).

Patterns in macaw deposition have led some to suggest that, in addition to feather procurement, sacrificial rituals were a driving factor for macaw demand in the SW/NW. McKusick (2001) suggests that scarlet macaws were utilized in sacrificial rituals associated with the vernal equinox. Ethnographic and ethnohistoric evidence from Puebloan groups of the U.S. Southwest suggest close associations between the scarlet macaw, the sun, and agriculture (Tyler 1991). Scarlet macaws typically nest in March and the young produce their first full tail feathers eleven to twelve months later in what Hargrave (1970) called the "newfledged" stage of development right around the time of the Spring Equinox, at which point most macaws at Paquimé—and elsewhere in the

SW/NW—were killed (but see Crown 2016 for a critique of Hargrave's "newfledged" age category). Prior to death, macaws at Paquimé were likely plucked, as evidenced by the small size of their burial cists, which would not have accommodated long tail feathers (McKusick 1974). Finally, many macaws from Paquimé were deposited in plazas, which may be the locations of Spring Equinox rituals, and occasionally multi-bird deposits were organized in a circular configuration (McKusick 1974). Though the reasoning behind these deposits may never be fully understood, Whittlesey and Reid (2013) find evidence of similar patterning at Grasshopper Pueblo in eastern Arizona. Turkeys were given similar depositional treatments at Paquimé and McKusick (1974) notes a circular sacrificial deposition at the site of Tseh So in Chaco Canyon in northwestern New Mexico.

Though there is extensive evidence for macaw keeping at Paquimé, there is also evidence for the exploitation of distant social connections and/or long-distance travel to acquire these macaws independent of a larger ritual economy. Given the similarities in depositional patterns seen at Paquimé with those seen elsewhere in the SW/NW, it is plausible that Paquimé could have supplied the U.S. Southwest with the birds themselves as well as the suite of ritual practices accompanying their care. However, scarlet macaws have been found in parts of the SW/NW at earlier points in time, such as in the Mimbres and Hohokam regions and at Chaco Canyon in northwestern New Mexico (Creel and McKusick 1994; Gilman et al. 2014; Lang and Harris 1984; Minnis et al. 1993; Olsen and Olsen 1974; Ruble 1996; Vokes and Gregory 2009; Watson et al. 2015; Whittlesey and Reid 2013). A radiocarbon study dating scarlet macaw remains from Chaco Canyon and elsewhere found that macaws were an important aspect of ritual leaders legitimizing their authority at Pueblo Bonito in the 10th century (Watson et al. 2015). Working in the Mimbres region of southwestern New Mexico, Gilman et al. (2014) explore the possibility of long-distance acquisition of scarlet macaws by individuals keen to gain prestige through the esoteric knowledge of macaw care and travel to distant, possibly dangerous lands. While Paquimé certainly could have been a center of macaw exchange to the U.S. Southwest, the possibility of independent long-distance acquisition remains for other parts of the SW/NW.

More recently, genetic evidence has suggested the presence of a pre-Hispanic scarlet macaw breeding colony that pre-dates Paquimé. George et al. (2018) conducted ancient DNA analysis on a sample of scarlet macaws recovered from the Chaco Canyon and Mimbres regions, both of which pre-date Paquimé, as well as a range of modern wild scarlet macaw remains from southern Mexico and parts of Central America. They found that the sampled archaeological specimens were members of a relatively rare and genetically distinct haplogroup (Haplo6) and that given this low haplotypic diversity, they must have resulted from a pre-Hispanic breeding program in the SW/NW that was actively transporting immature macaws throughout the SW/NW between 900 and 1200 CE. Though the authors were unable to sample modern wild birds from the northernmost extent of the range of scarlet macaws in northern Veracruz and southern Tamaulipas—the nearest distance to the SW/NW and an area of known macaw aviculture (Nelson et al. 2021)—they suggest that Haplo6 is unlikely to be abundant in this region. Haplo6 was observed in only three of 84 sampled modern macaws, two from the Gulf Coast/Isthmus of Tehuantepec region and one from northern Guatemala. Plog et al. (2021) state that though the exact location of this pre-1250 CE breeding colony is unknown, it is likely to be located in northern Mexico in the vicinity of Paquimé. After 1250 CE, Paquimé appears to be a potential center for raising and transporting macaws into other parts of the SW/NW. It is also possible that macaws recovered from excavations at Paquimé were transported as young birds from elsewhere in the SW/NW.

Exploring Long-Distance Exchange through Radiogenic Strontium Isotope Analysis

Isotopic studies have been increasingly successful in assessing the long-distance exchange and acquisition of faunal resources (e.g., Chase et al. 2018; Díaz-Zorita Bonilla, et al. 2017; Ma et al. 2015; Minniti et al. 2014; Somerville et al. 2010, 2020; Sugiyama et al. 2018; Szpak et al. 2015; Thornton 2011; Thornton et al. 2011; Viner et al. 2010). Radiogenic strontium has proven particularly useful for examining past animal exchange patterns (Thornton 2011). The question of whether Paquimé's scarlet macaw population was locally raised or imported from outside the region can be assessed because radiogenic strontium isotope values ($^{87}Sr/^{86}Sr$) vary worldwide based on the age and composition of underlying bedrock (Bentley 2006; Ericson 1985; Knudson et al. 2010; Price et al. 2002). Assuming that the humans and animals being analyzed consumed primarily local strontium sources, $^{87}Sr/^{86}Sr$ values in enamel and bone' tissue are reflective of local bedrock values (Bentley 2006). Food and water consumed by animals are recorded in skeletal tissues as strontium substitutes for calcium in the process of bone and tooth enamel mineralization. Therefore, local $^{87}Sr/^{86}Sr$ values are incorporated during tooth enamel formation and during bone remodeling throughout the lifetime of an organism (Bentley 2006).

Radiogenic strontium isotopes do fractionate, though they are far less susceptible to fractionation than light stable isotopes (e.g., $^{18}O/^{16}O$) and thus will not vary according to an organisms' metabolism, body size, or diet (Blum et al. 2000; Ezzo 1994; Price et al. 2002; Thornton 2011). The minor fractionation that occurs as radiogenic strontium isotopes move through an ecosystem is corrected through analysis on a mass spectrometer (Bentley 2006). However, natural processes such as differential weathering of bedrock, sea spray, and blowing dust can impact what are considered local $^{87}Sr/^{86}Sr$ values by affecting strontium uptake in ecological systems (Bentley and Knipper 2005; Ericson 1985; Probst et al. 2000; Veizer 1989; Whipkey et al. 2000; see overview in Bentley 2006).

Sources of Strontium in Scarlet Macaw Diet

Investigation of light stable isotopes in scarlet macaw bone tissue recovered from Paquimé by Somerville et al. (2010) revealed that macaws were consuming primarily hand-fed maize. As is discussed below, maize kernels have relatively low strontium concentrations so scarlet macaws at Paquimé probably acquired strontium through various other avenues, including local water sources, terrestrial food sources, and surrounding soils through geophagy—the consumption of minerals in soil.

The Rio Casas Grandes has the largest watershed in the region and likely provided both agricultural and domestic water for the inhabitants of Paquimé (Minnis and Whalen 2015b). The presence of reservoirs and extensive water control features within the settlement of Paquimé attests to the importance of local water management in daily life (Di Peso 1974). Extensive irrigation systems brought water from rivers to irrigate lowland fields in the Rio Casas Grandes floodplain within five kilometers around Paquimé, where there would have been 2,000 hectares of arable land (Minnis and Whalen

2001). Minnis and Whalen (2015) note that farming was relatively successful in the region around Paquimé, and probably centered around lowland river valleys and upland locales. The latter was probably more productive and practiced at a greater distance from Paquimé (almost 400 examples of terracing and rock mulch features have been observed within 20 km of Paquimé) (Minnis et al. 2006; Minnis and Whalen 2015b). Maize was the most common staple crop, but other foods were certainly important, including squashes (*Cucurbita* sp.) and gourds (*Lagenaria* sp.), beans (*Phaseolous vulgaris*), and chiles (*Capsicum annuum*) (Minnis and Whalen 2010). Maize and cotton appear to have been more commonly grown in upland locales while maize, squash, and beans were more common in lowland river valleys. With the exception of maize, many of the resources macaws could have consumed, such as legumes, seeds, and nuts, have relatively with high strontium concentrations (Ericson 1985). Squash seeds, acorns (*Quercus* sp.), piñon pine nuts (*Pinus cembroides*), and juniper berries (*Juniperus* sp.) would likely have been incorporated into macaw diets, as would seeds of goosefoot (*Chenopodium* sp.), pigweed (*Amaranthus* sp.), and purslane (*Portulaca* sp.) (Minnis and Whalen 2015b). Cacti, including prickly pear fruits and pads (*Opuntia* sp.), and agave (*Agave* sp.) and yucca (*Yucca* sp.) were also locally available and could have been fed to macaws. A diet incorporating this array of maize, nuts, seeds, and fruit would actually constitute a relatively healthy diet for a scarlet macaw (Chapter 2). The potential for resources like maize and cotton to be grown up to 20 km away indicates that an archaeological faunal baseline—that would demonstrate potential mixing of maize grown from up to 20 km away and transported to Paquimé with more locally-available nuts and seeds is a strong option for this analysis (Price et al. 2002).

For a regional center like Paquimé, the importation of non-local resources for consumption is a possible concern, even for scarlet macaws. In the greater SW/NW, non-local, non-marine salt is a dietary and ritually important resource that is sometimes associated with parrots (Kinnear-Ferris et al. 2015; Tyler 1991:25-26). Ritually-prescribed travel to locales such as the Zuni Salt Lake to procure salt is one example of human behavior that could possibly contribute to variations in local $^{87}Sr/^{86}Sr$ signatures (Ferguson et al. 2010; Kuwanwisiwma and Ferguson 2004; Malotki 2003; Kinnear-Ferris et al. 2015). This is especially true of agriculture-based societies that might not intake as much salt as the relatively meat-abundant diets of hunter-gatherers (Kinnear-Ferris et al. 2015). Based on excavation reports (Di Peso 1974; Di Peso et al. 1974) and prior biogeochemical investigations (Somerville et al. 2010), there is little evidence to support the hypothesis that these resources made up a substantial portion of the diet of Paquimé's population of scarlet macaws.

Finally, wild scarlet macaws have been observed practicing geophagy, or the consumption of clay and soil. Brightsmith et al. (2018) observed a population of wild Peruvian macaws and found that peak clay lick use coincided with breeding seasons, which supports the hypothesis that geophagy was practiced at times when additional minerals are needed to support egg formation and chick growth. This behavior is especially likely to have affected the "Immature", "Adult I" or "Adult II" scarlet macaw specimens in this study. Macaws also commonly use their beaks to move themselves around and often pick at their surroundings (Chapter 2), which might have the unintentional effect of consuming trace amounts of soils. High strontium concentrations in soils would incorporate $^{87}Sr/^{86}Sr$ values representative of the materials used in construction, such as adobe used in the construction of macaw pens at Paquimé and plasters commonly used in floors and walls. Of course, the possibility remains that the birds were primarily allowed to fly freely and may not have been confined to room or adobe pen contexts (Chapter 2), which would result in more variable $^{87}Sr/^{86}Sr$ values.

Potential for Diagenetic Contamination in Macaw Bone Tissue

An important concern is diagenetic contamination, or the post-depositional incorporation of non-biogenic strontium into bone. Diagenetic contamination can be examined through major, minor, and trace elemental concentrations. The calcium to phosphorus ratio (Ca/P) examines the enrichment or depletion of calcium and phosphorus, which have direct effects on strontium levels in bone, and speak to the preservation of bone mineral (Mays 2003; Price et al. 1992; Price et al. 1994). Researchers have argued that rinsing bone samples in weak acetic acid dissolves away diagenetic strontium present in pore spaces but loosely bound in the calcium site of bone hydroxyapatite, while leaving strongly-bound biogenic strontium (Bentley 2006; Price et al. 1994; Sillen et al. 1989). Price et al. (1994) suggest that Ca/P ratios nearing 2.1 demonstrate a largely biogenic value for calcium and strontium. Kohn et al. (1999) suggest that increased levels of uranium and rare earth elements (REEs) in human teeth can be indicative of chemical alteration in apatite. Thus, a low ratio of uranium to calcium (U/Ca) has been used to indicate minimal post-depositional contamination and strong preservation (Alonzi et al 2019; Knudson et al. 2012; Price et al. 2002). Finally, Kamenov et al. (2018) caution of the relatively high potential for diagenesis in archaeological bone and introduced Maximum Threshold Concentrations (MTC) for archaeological tooth enamel, above which readings of elemental concentrations may be indicative of major diagenetic alteration. Elemental concentrations were utilized to assess the possibility of diagenetic contamination in this analysis.

Models for Assessing the Acquisition of Scarlet Macaws

Radiogenic strontium values in scarlet macaws from Paquimé can be interpreted from the examination of two models, which have implications for understanding the development of Paquimé. The first comes from recent research on the Viejo (700-1150 CE) and Medio (1150/1200-1450/1475 CE) periods of the Casas Grandes region that has led researchers to suggest a model of local development, whereby Paquimé developed from local populations that manipulated rare, non-local objects and materials (Kelley et al. 2012; Offenbecker 2018; Whalen and Minnis 2003). Whalen and Minnis (2003) note that "southern exotica" such as marine shell, copper, and macaws were all present during the Viejo period, prior to the Medio period florescence of Paquimé. They acknowledge the importance of distant contacts and trade in the establishment of the region, but see it "…in the context of local initiatives and aspirations" (Whalen and Minnis 2003). Here, the knowledge of macaw keeping would have been retained from the Viejo period and scarlet macaws raised locally, with perhaps the occasional acquisition of non-local scarlet macaws to supplement the local populations.

An alternate scenario involves the persistent manipulation of distant connections and travel to the south to acquire scarlet macaws. Gilman et al. (2014) argue that people from the Mimbres region of southwestern New Mexico routinely traveled south to the geographical homelands of scarlet macaws, military macaws, and thick-billed parrots as a quest in the pursuit of ritual knowledge (Figure 8). Drawing on the work of Mary Helms

(1991), they argue that overcoming the dangers associated with distant travel to acquire ceremonial paraphernalia (i.e., the birds) and the esoteric knowledge necessary to care for the birds would grant them ritual power. Though the Mimbres Classic period (1000-1130 CE) predates the apogee of the Casas Grandes region, people at Paquimé could have participated in similar treks and over hundreds of years, consecutive trips to Mesoamerica could have accounted for the acquisition of the large quantities of scarlet macaws found at Paquimé. Possibility of shared distant connections is supported by recent evidence from mitochondrial DNA in archaeological human remains that found closer similarity between individuals from Paquimé and those from the Mimbres region than those from any other parts of the SW/NW (Morales-Arce 2017; Morales-Arce et al. 2017).

A local $^{87}Sr/^{86}Sr$ baseline for this study is based on Offenbecker (2018), who analyzed archaeological kangaroo rat (*Dipodomys* sp., n = 8) and jackrabbit (*Lepus californicus*, n = 2) specimens from Paquimé as well as faunal specimens from surrounding settlements. Offenbecker (2018:73-75) establishes a local $^{87}Sr/^{86}Sr$ range of 0.7068 – 0.7075, which is the mean ± 3σ ($^{87}Sr/^{86}Sr$ = 0.70715 ± 0.00033, 3σ, [n = 10]), for the settlement of Paquimé. Though the norm in $^{87}Sr/^{86}Sr$ faunal baselines is a mean ± 2σ, Offenbecker (2018) expands to 3σ to better fit the central distribution of human $^{87}Sr/^{86}Sr$ values observed in the Paquimé population and to account for the sampling of primarily kangaroo rats (*Dipodomys sp.*), which have a very confined home range (<200 m). Table 1 summarizes the local faunal baseline $^{87}Sr/^{86}Sr$ values for the Casas Grandes

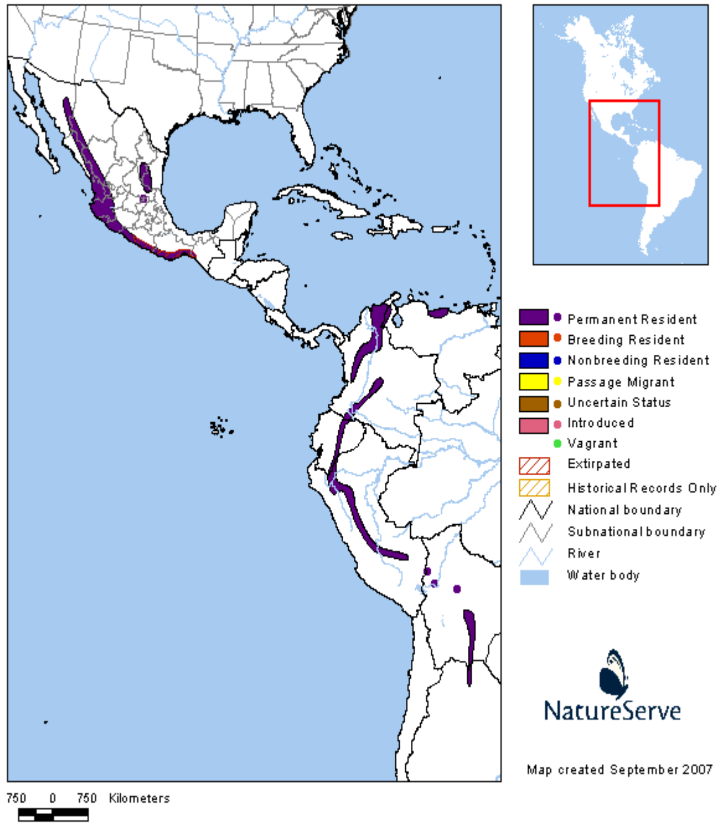


Figure 8. Geographical distribution of the military macaw (*Ara militaris*) throughout the Americas (from Ridgely et al. 2005).

region.

Faunal baseline data provide expectations to test the models posed above. If scarlet macaws at Paquimé were primarily bred locally as is suggested in a local development model, we expect that $^{87}Sr/^{86}Sr$ values for macaw bones would fall within Paquimé's local range of $^{87}Sr/^{86}Sr = 0.70682 – 0.70748$ or within the local ranges presented for the Casas Grandes region. Conversely, if scarlet macaws were actively transported from Mesoamerica, as is posited by a long-distance acquisition model, we would expect that scarlet macaw bone $^{87}Sr/^{86}Sr$ values would fall outside of the local range defined above. Given the large geographical range of the scarlet macaw and the high variability of

Table 1. Local baselines derived from archaeological fauna $^{87}Sr/^{86}Sr$ values for the Casas Grandes region in Chihuahua, Mexico. Table adapted from Offenbecker (2018).
*Paquimé $^{87}Sr/^{86}Sr$ local range is archaeological fauna mean ± 3σ.
** Only three animals were sampled in the creation of a local baseline for Site 315.

Site	Region	$^{87}Sr/^{86}Sr$ Local Baseline (Faunal Mean ± 2σ)
76 Draw	Mimbres	0.7093-0.7097
Paquimé	Casas Grandes	0.7068-0.7075*
Site 315	Casas Grandes	0.7065-0.7075**
Cerro Juanaqueña	Casas Grandes	0.7072-0.7080
Ch-254	Casas Grandes	0.7065-0.7067

bedrock $^{87}Sr/^{86}Sr$ values throughout southern Mexico and the Yucatán Peninsula (as well as in Central and South America) (Price et al. 2008), it is difficult to estimate $^{87}Sr/^{86}Sr$ values for zones of procurement. However, $^{87}Sr/^{86}Sr$ baseline values from Price et al. may offer suggestions of possible locales of origin.

Of course, these hypotheses are necessarily simplified and the possibility remains that elements from the sample will fall somewhere in between, with most macaws bred locally while a few were imported to supplement the Paquimé population or vice versa. For example, in their study of oxygen isotopes ($^{18}O/^{16}O$) Somerville et al. (2010) find that most macaws were raised locally, though one of the birds could have been brought from a more distant location to supplement the local population.

Materials and Methods

Materials and Sampling Strategy

Scarlet macaw bone samples listed in Table 2 were selected from archaeological collections housed at the Museo de las Culturas del Norte in Casas Grandes, Chihuahua by Andrew Somerville. In total, 30 bones were selected (femur n = 10; humerus n = 18; tibiotarsus n = 2) from 30 scarlet macaws of varying ages at death (Table 2). An attempt was made to include individuals of all stages of development (i.e., nestling, juvenile, immature, newfledged, adolescent, breeding, aged), though no juvenile (seven weeks to four months of age) or aged (greater than four years) birds were included in this analysis due to the lack of suitable elements for sampling (Somerville et al. 2010). Well-preserved long bones were selected for sampling because denser cortical bone is expected to better preserve biogenic symbols and bone turnover occurs more slowly than in less dense bones. Somerville et al. (2010) note that while the turnover rate of macaw bone is unknown, bone from the comparably-sized turkey vulture is known to have a half life of >600 days (Fry 2004). Because most bones sampled here are from immature macaws (4-11 months of age), isotope values should represent lifetime averages (Somerville et al. 2010).

Preparation of Samples for Elemental Concentrations and Radiogenic Strontium Analysis

All preparation for elemental concentration and radiogenic strontium isotope analysis occurred at Arizona State University in the Archaeological Chemistry Laboratory (ACL) based on established laboratory methods (Alonzi et al. 2019; Knudson et al. 2016). Initial cleaning of bone cortex and removal of trabecular bone was conducted by A. Somerville with a Dremel drill (Somerville et al. 2010). Dense cortical bone was preferred for this analysis as it is less likely to be impacted by post-depositional contaminants. All bone samples were powdered using an agate mortar and pestle and

Table 2. Archaeological scarlet macaw (*Ara macao*) remains from Paquimé included in this study. Table adapted from Somerville et al. (2010:130).

Sample No.	Spec. No.	Provenience	Age	Bone	Notes
ACL-0812	CG-240	Plaza 3-12	Immature	Humerus	Multiple burial - 2 scarlet
ACL-0813	CG-227	Plaza 3-12	Newfledged	Femur	Single articulated plaza burial
ACL-0814	CG-49	Room 36-11	Adult II	Humerus	Multiple burial - 3 scarlet, 2 indeterminate macaw species
ACL-0815	CG-237	Plaza 3-12	Immature or older	Humerus	Single articulated plaza burial
ACL-0816	CG-272-3	Plaza 3-12	Immature	Femur	Multiple burial - 2 scarlet
ACL-0817	CG-258	Plaza 3-12	Immature	Humerus	Multiple burial - 3 scarlet
ACL-0818	CG-68	Plaza 6-12	Immature	Tibio tarsus	Multiple burial - 3 scarlet, 1 indeterminate macaw species
ACL-0819	CG-46	Room 36-11	Immature	Tibio tarsus	Multiple burial - 3 scarlet, 2 indeterminate macaw species
ACL-0820	CG-0a	Plaza 3-12	Immature	Humerus	Multiple burial - 5 scarlet, 4 indeterminate macaw species
ACL-0821	CG-244	Plaza 3-12	Immature	Femur	Single articulated plaza burial
ACL-0822	CG-364.1	Plaza 3-11	Immature	Femur	Multiple burial - 8 scarlet
ACL-0823	CG-0b	Plaza 3-12	Nestling	Humerus	Multiple burial - 5 scarlet, 4 indeterminate macaw species
ACL-0824	CG-255	Plaza 3-12	Immature or older	Humerus	Multiple burial - 2 scarlet, 1 military
ACL-0825	CG-248	Plaza 3-12	Adult I	Humerus	Multiple burial - 1 scarlet, 1 indeterminate macaw species
ACL-0826	CG-305	Room 2-18 Platform	Immature	Humerus	Multiple burial - 6 scarlet
ACL-0827	CG-89	Plaza 3-11	Immature	Humerus	Multiple burial - 3 scarlet, 1 indeterminate macaw species
ACL-0828	CG-259	Plaza 3-12	Immature or older	Femur	Multiple burial - 3 scarlet
ACL-0829	CG-325	Room (Plaza) 19-8	Adult II	Humerus	Without head; multiple burial - 29 scarlet, 4 military, 1 indeterminate macaw species
ACL-0830	CG-257	Plaza 3-12	Immature or older	Femur	Multiple burial - 3 scarlet
ACL-0831	CG-267	Plaza 3-12	Immature or older	Femur	Single articulated plaza burial
ACL-0832	CG-319	Room (Plaza) 19-8	Immature	Humerus	At feet of human burial
ACL-0833	CG-110	Plaza 3-12	Immature	Femur	Single articulated plaza burial
ACL-0834	CG-75	Plaza 5-12	Immature	Femur	Multiple burial - 2 scarlet, 1 indeterminate macaw species
ACL-0835	CG-109	Plaza 3-12	Immature or older	Femur	Multiple burial - 1 scarlet, 1 indeterminate macaw species; buried with Dosinia armlet fragment
ACL-0836	CG-79	Plaza 5-12	Immature	Humerus	Single articulated plaza burial
ACL-0837	CG-246	Plaza 3-12	Immature	Femur	Single articulated plaza burial
ACL-0838	CG-297	Room 28-8	Immature	Humerus	Single subfloor burial
ACL-0839	CG-82	Plaza 3-11	Newfledged	Humerus	Multiple burial - 5 scarlet, 1 indeterminate macaw species, 1 military
ACL-0840	CG-70	Plaza 6-12	Adult II	Humerus	Multiple burial - 3 scarlet, 1 indeterminate macaw species
ACL-0841	CG-245	Plaza 3-12	Immature	Humerus	Single articulated plaza burial

stored in acid-washed vials. When possible, 0.0400g of powdered bone was taken from each sample for chemical cleaning. If the remaining sample was less than 0.0400g, then the total amount of remaining sample was taken for chemical cleaning. Powdered bone samples were rinsed for thirty minutes in Millipore water (18.2 MΩ) using an ultrasonic cleaner, followed by a thirty-minute rinse in 5 mL of 0.8 M acetic acid (CH_3COOH). The samples were rinsed in 5 mL of Millipore water (H_2O) in the ultrasonic cleaner for five minutes and placed in the oven to dry at 50˚C for one hour. The samples were then ashed at 800˚C for 10 h in a Thermo Scientific Lindberg Blue box furnace and powdered with an agate mortar and pestle.

Major, Minor, and Trace Elemental Concentrations

Final preparation for elemental concentration analysis was performed at the Metal, Environmental, and Terrestrial Analytical Laboratory (METAL) at ASU. Stock solutions were created by dissolving 0.0030 g of powdered bone ash in 0.5 mL of trace-metal grade concentrated (15.5-16 M) nitric acid (HNO_3) and 3.50 mL of Millipore water (H_2O). Once the sample was fully dissolved, 0.53 mL of the stock solution was diluted with 14.47 mL of twice-distilled 0.32 M nitric acid (HNO_3). Major, minor, and trace elemental concentrations were then analyzed on a Thermo-Finnigan series quadrupole inductively-coupled plasma mass spectrometer (Q-ICP-MS) to assess diagenetic contamination.

Strontium Isotope Separation and Analysis of Isotopic Ratios

At METAL, biogenic strontium was separated from the sample matrix using the new, automated PrepFAST system (Romaniello et al. 2015). Trace elemental concentrations were used to calculate amounts of stock solution and 2 M twice-titrated nitric acid (HNO_3) to add to each sample in anticipation of strontium separation. Blanks, internal standards, NIST-1400, and pre- and post-chemistry aliquots were also prepared to assess factors affecting strontium separation. After strontium separation, all samples were placed in Teflon vials and heated on a hot plate for ~6 h. After cooling, 0.5 mL of concentrated (15.5-16 M) distilled nitric acid (HNO_3) and 0.1 mL of 30% hydrogen peroxide (H_2O_2) were added to the vials. Vials were closed immediately and heated on the hot plate overnight. All samples were then uncapped to evaporate and given 1 mL of 0.32 M nitric acid (HNO_3). Samples were then capped and dissolved on the hot plate for ~30 m. This solution was then transferred to 15 mL centrifuge tubes and brought up to an optimal final volume with 0.32 M nitric acid (HNO_3). Strontium isotope ratios were then measured on a Neptune multi-collector inductively coupled plasma mass spectrometer (MC-ICP-MS), where analyses of strontium carbonate standard SRM-987 yielded a value of $^{87}Sr/^{86}Sr = 7.10264 \pm 0.000014$ (2σ, n = 27).

Results

Isotopic and elemental data from archaeological macaw bone samples are presented in Table 3. Mean archaeological macaw bone strontium isotope values from Paquimé are $^{87}Sr/^{86}Sr = 0.70751 \pm 0.00113$ (2σ, n = 29). Archaeological macaw bone strontium isotope values range from $^{87}Sr/^{86}Sr = 0.70687$ to $^{87}Sr/^{86}Sr = 0.70968$.

Elemental concentrations of calcium, phosphorus, and uranium were obtained to assess the preservation of bone tissue. For archaeological scarlet macaw samples, mean Ca/P = 1.93 ± 0.09 (2σ, n = 30) and mean U/Ca = $4.22 \times 10^{-6} \pm 1.151 \times 10^{-5}$ (2σ, n = 30).

Table 3. Contextual information, elemental concentration, and isotope data from archaeological scarlet macaw (*Ara macao*) samples from Paquimé.

Sample No.	Spec. No.	Provenience	Age	Bone	Ca/P	U/Ca	$^{87}Sr/^{86}Sr$
ACL-0812	CG-240	Plaza 3-12	Immature	Humerus	1.95	4.15E-07	0.70725
ACL-0813	CG-227	Plaza 3-12	Newfledged	Femur	1.94	5.00E-06	0.70741
ACL-0814	CG-49	Room 36-11	Adult II	Humerus	1.91	6.97E-08	0.70760
ACL-0815	CG-237	Plaza 3-12	Immature or older	Humerus	1.92	1.64E-06	0.70784
ACL-0816	CG-272-3	Plaza 3-12	Immature	Femur	1.93	6.96E-07	0.70728
ACL-0817	CG-258	Plaza 3-12	Immature	Humerus	1.93	9.40E-07	0.70799
ACL-0818	CG-68	Plaza 6-12	Immature	Tibiotarsus	1.98	9.19E-06	0.70740
ACL-0819	CG-46	Room 36-11	Immature	Tibiotarsus	1.85	6.28E-08	0.70821
ACL-0820	CG-0a	Plaza 3-12	Immature	Humerus	1.93	1.06E-05	0.70723
ACL-0821	CG-244	Plaza 3-12	Immature	Femur	1.91	6.24E-06	0.70779
ACL-0822	CG-364.1	Plaza 3-11	Immature	Femur	1.92	2.26E-06	0.70718
ACL-0823	CG-0b	Plaza 3-12	Nestling	Humerus	1.88	1.07E-05	0.70747
ACL-0824	CG-255	Plaza 3-12	Immature or older	Humerus	1.92	3.23E-06	0.70746
ACL-0825	CG-248	Plaza 3-12	Adult I	Humerus	1.97	2.63E-05	0.70673
ACL-0826	CG-305	Room 2-18 Platform	Immature	Humerus	2.14	1.74E-05	0.70775
ACL-0827	CG-89	Plaza 3-11	Immature	Humerus	1.92	1.28E-06	0.70744
ACL-0829	CG-325	Room (Plaza) 19-8	Adult II	Humerus	1.90	3.05E-06	0.70702
ACL-0830	CG-257	Plaza 3-12	Immature or older	Femur	1.91	9.79E-07	0.70844
ACL-0831	CG-267	Plaza 3-12	Immature or older	Femur	1.92	3.44E-07	0.70743
ACL-0832	CG-319	Room (Plaza) 19-8	Immature	Humerus	1.90	1.57E-06	0.70717
ACL-0833	CG-110	Plaza 3-12	Immature	Femur	1.91	1.89E-06	0.70731
ACL-0834	CG-75	Plaza 5-12	Immature	Femur	1.94	1.82E-06	0.70728
ACL-0835	CG-109	Plaza 3-12	Immature or older	Femur	1.93	2.16E-06	0.70702
ACL-0836	CG-79	Plaza 5-12	Immature	Humerus	1.93	8.79E-07	0.70687
ACL-0837	CG-246	Plaza 3-12	Immature	Femur	1.92	5.03E-06	0.70725
ACL-0838	CG-297	Room 28-8	Immature	Humerus	1.92	4.47E-07	0.70724
ACL-0839	CG-82	Plaza 3-11	Newfledged	Humerus	1.92	4.84E-06	0.70730
ACL-0840	CG-70	Plaza 6-12	Adult II	Humerus	1.94	5.51E-06	0.70727
ACL-0841	CG-245	Plaza 3-12	Immature	Humerus	1.93	6.65E-07	0.70968

Discussion

Diagenetic Contamination

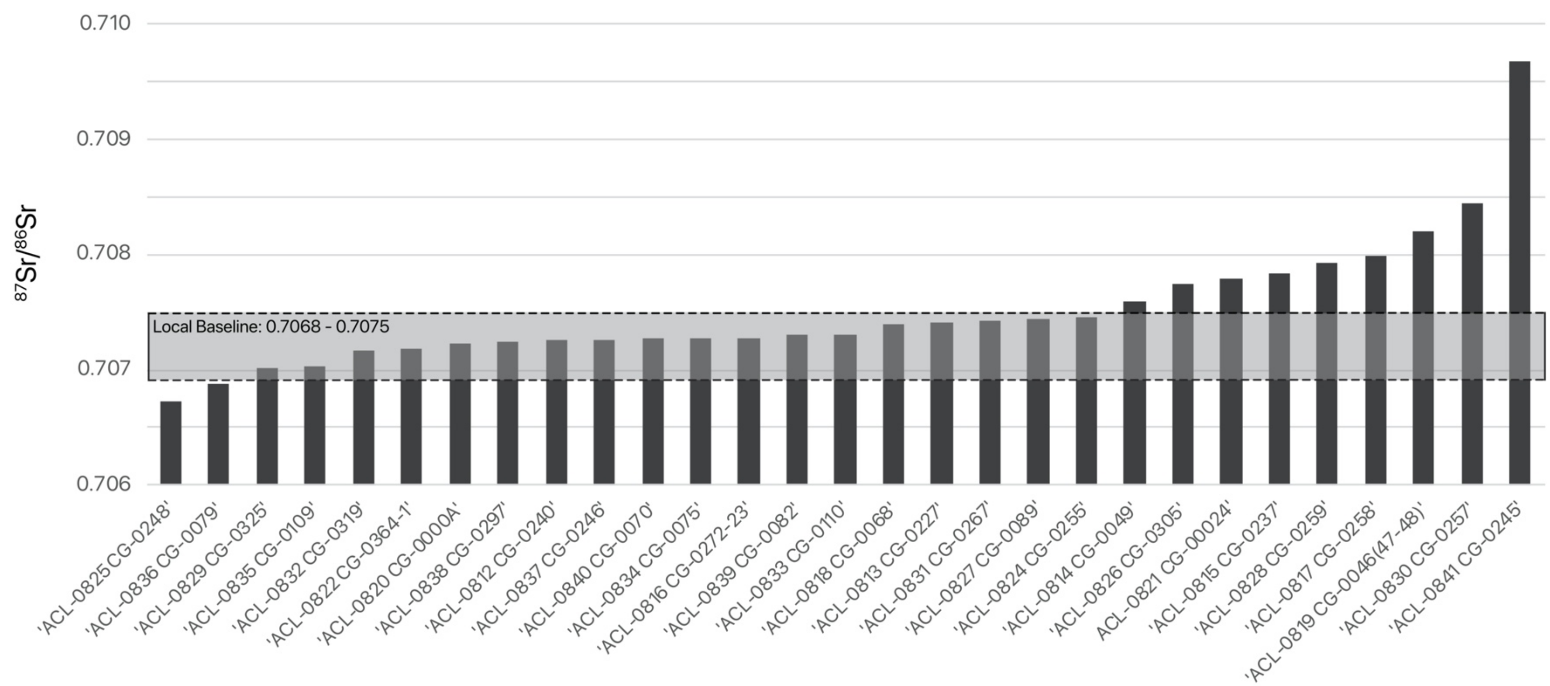
Results from major, minor, and trace elemental concentrations run from this sample of Paquimé scarlet macaws suggest that little to no diagenetic contamination affected these specimens. Most samples fall below the expected human apatite ratio of 2.1:1 (Price et al. 1992). Zaichick and Tzaphlidou (2002) report Ca/P values in modern humans as 2.17 ± 0.31 (1σ, n = 78) and all but one sample, ACL-0819 CG-0046(47/48), fall within this range. U/Ca ratios are comparable to those published by Knudson et al. (2014:315) for uncontaminated human bone and enamel (U/Ca = $4.22 \times 10^{-6} \pm 6.39 \times 10^{-6}$ [2σ, n = 14]) as well as those for faunal bone and enamel (U/Ca = $1.74 \times 10^{-7} \pm 1.29 \times 10^{-7}$ [2σ, n = 9]).

Locality of Paquimé Scarlet Macaws

The majority (n = 19) of sampled scarlet macaws from Paquimé demonstrate $^{87}Sr/^{86}Sr$ values indicative of a local origin, while $^{87}Sr/^{86}Sr$ values from ten macaws indicate a non-local origin (Figure 9). Of the non-local specimens, one measures slightly below Paquimé's local range at $^{87}Sr/^{86}Sr$ = 0.70673. A similar pattern was seen in Offenbecker's (2018) analysis of human bone tissue from Paquimé. She argues that these individuals were likely from the Casas Grandes region, but migrated into Paquimé from two settlements in south-central Chihuahua (Ch-254 and neighboring Ch-159). The archaeological site of Ch-254 has a local range of $^{87}Sr/^{86}Sr$ = 0.70646 to $^{87}Sr/^{86}Sr$ = 0.70674 (mean $^{87}Sr/^{86}Sr$ = 0.70660 ± 0.00007, 2σ, [n = 10]).

Six macaw samples (ACL-0814, ACL-0826, ACL-0821, ACL-0815, ACL-0828, ACL-0817) measure slightly above Paquimé's local range, between $^{87}Sr/^{86}Sr$ = 0.70760 and $^{87}Sr/^{86}Sr$ = 0.70799. A similar result was observed in human bone tissue recovered from Paquimé by Offenbecker (2018:74-80), who suggests that this range of $^{87}Sr/^{86}Sr$ values includes human individuals from within the Casas Grandes region who may have migrated from Cerro Juanaqueña, a settlement located approximately 80 km to the north near the modern town of Janos in northern Chihuahua.

Figure 9. $^{87}Sr/^{86}Sr$ values for 29 archaeological scarlet macaw remains from Paquimé. Local $^{87}Sr/^{86}Sr$ baseline for Paquimé in grey.



An additional two macaw samples (ACL-0819 and ACL-0830) fall between $^{87}Sr/^{86}Sr = 0.70820$ and $^{87}Sr/^{86}Sr = 0.70844$. This range falls outside expected local and non-local signatures in Offenbecker's analysis of Paquimé's human skeletal population. However, it does fall within published $^{87}Sr/^{86}Sr$ values for the Yucatan Peninsula in southern Mexico (Price et al. 2008; Thornton 2011), which is a location that falls within the endemic range of scarlet macaws and may have been a source area for the procurement of live birds (Gilman et al. 2014; Price et al. 2008). However, verifying such a possibility requires additional baseline sampling.

Finally, one outlying specimen (ACL-0841) has a $^{87}Sr/^{86}Sr$ value of 0.70968. This falls outside of Offenbecker's (2018:74) expected within-region $^{87}Sr/^{86}Sr$ values, but within the expected local $^{87}Sr/^{86}Sr$ value range for the settlement of 76 Draw ($^{87}Sr/^{86}Sr = 0.70925$ to $^{87}Sr/^{86}Sr = 0.70972$), located within the Mimbres region of southwestern New Mexico. Despite substantial evidence for aviculture at Paquimé, including the presence of adobe macaw pens and eggshell, large quantities of young macaws, and a majority of locally raised macaws seen here, these results suggest that Paquimé's macaw population was supplemented with additional scarlet macaws from either surrounding SW/NW regions or more distant parts of Mexico.

Comparing Radiogenic Strontium Isotope Data to Light Stable Isotope Data

Somerville and colleague's (2010) investigation of light stable oxygen isotopes in this same sample of scarlet macaws identified two outlying specimens that they concluded may have been the result non-local importation (Figure 10). They suggested that one individual, ACL-0818, demonstrated a relatively high $\delta^{18}O_{ap}$ value ($\delta^{18}O_{ap(V\text{-}SMOW)} = 27‰$, differing from the population mean by greater than 2 standard deviations)

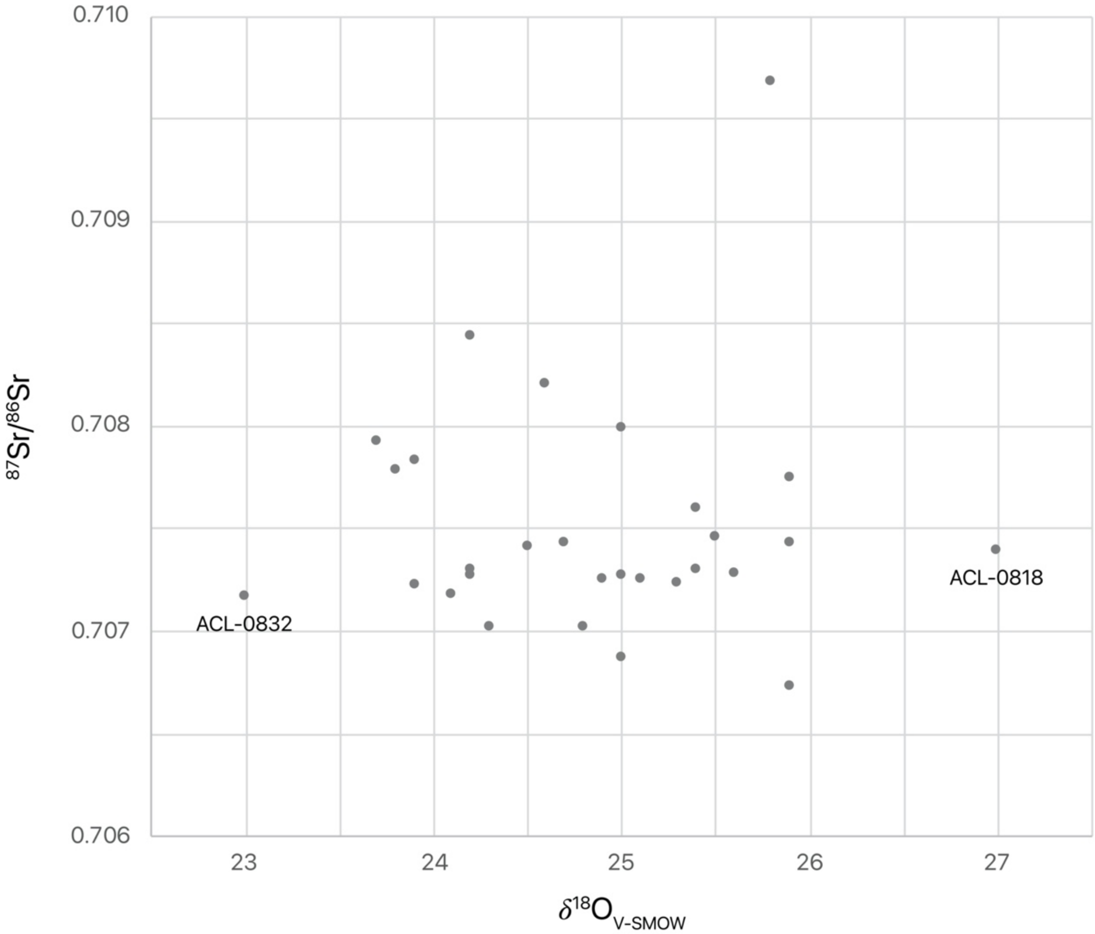


Figure 10. Scatterplot of $^{87}Sr/^{86}Sr$ and $\delta^{18}O_{ap(V\text{-}SMOW)}$ data from archaeological scarlet macaw remains from Paquimé.

because the sampled bone mineralized at a time when the bird was consuming water from a more southern location, such as the lowlands of Mesoamerica (Somerville et al. 2010:132). The observed $^{87}Sr/^{86}Sr$ value for this specimen is 0.70740, which falls within Paquimé's local $^{87}Sr/^{86}Sr$ range and in the center of observed $^{87}Sr/^{86}Sr$ values for the scarlet macaw population.

A second individual, ACL-0832, was identified as having the lowest $\delta^{18}O_{ap}$ value ($\delta^{18}O_{ap(V\text{-}SMOW)}$ = 23‰, also differing from the population mean by greater than 2 standard deviations) and the third most depleted carbon value of $\delta^{13}C_{ap(V\text{-}PDB)}$ of 0.3‰, indicating that this individual may have been imported to Paquimé from another highland Chihuahua site that bred parrots. The observed $^{87}Sr/^{86}Sr$ value for this specimen is 0.70717, which falls on the low end of observed $^{87}Sr/^{86}Sr$ values for Paquimé's scarlet macaw population, but near the center of Paquimé's local $^{87}Sr/^{86}Sr$ range. However, the possibility remains that this specimen may have been imported from another local center. Its $^{87}Sr/^{86}Sr$ value falls within the local $^{87}Sr/^{86}Sr$ range of Site 315 (also located in the Casas Grandes region of northwestern Chihuahua), though Offenbecker (2018:72) cautions that this range was calculated using only three rabbit (*Lepus sp.*) bone specimens and requires additional baseline sampling to establish a more reliable local range. Alternatively, this specimen may have been bred or raised at another settlement within the Casas Grandes region for which a local baseline was not established in Offenbecker's study.

Additionally, ACL-0835 exhibited outlying ^{13}C-depleted values ($\delta^{13}C_{ap(V\text{-}PDB)}$ = -7.8‰) that led Somerville et al. (2010:132) to note that the ACL-0835 may have been fed a special diet given its deposition alongside humans or it may have been a tropical import from Mesoamerica where it consumed more C_3 plants. The $^{87}Sr/^{86}Sr$ value for ACL-0835 falls within Paquimé's local range at 0.70702, suggesting that the ^{13}C depletion observed in this specimen was more probably due to a special diet—perhaps more similar to human diets or inclusive of more diverse foods (e.g., fruits, nuts, other C_3 plants) than the predominantly maize diet that most macaws at Paquimé were fed—afforded to this bird.

Interpreting Patterns in Scarlet Macaw Acquisition and Local Raising

Results from this study confirm that scarlet macaws were locally raised at Paquimé while also being supplemented by the importation of additional macaws. Most of the non-local scarlet macaws sampled here do not exhibit $^{87}Sr/^{86}Sr$ values consistent with acquisition from the neotropical natural range of scarlet macaws in east and southern Mexico ranging into Central and South America (Abramson et al. 1995). The $^{87}Sr/^{86}Sr$ values in non-local birds instead suggest that scarlet macaws may have been imported from relatively close settlements located within the Casas Grandes interaction sphere or from the greater SW/NW.

This finding is in agreement with a local development model, whereby macaws and their products were locally produced and interpreted for use within the Casas Grandes region. The knowledge of macaw keeping—and perhaps macaw breeding—could have served as a source of ritual and ceremonial power for those that inhabited Paquimé. This is contrary to the traditional interpretation of Paquimé as a mercantile center that produced and exported objects and materials (Di Peso 1974; Minnis et al. 1993; Vokes and Gregory 2007), but in agreement with more recent interpretations of Paquimé as a regional ceremonial center where rare, non-local objects and materials were imported and kept as sources of ritual authority (Whalen 2013; Whalen and Minnis 2015). Of course, the results do not preclude the importation of scarlet macaws from surrounding Casas Grandes settlements. It is also possible that Paquimé was supplying the rest of the SW/NW with scarlet macaws between 1200 and 1450 CE and additional studies will be needed to address this possibility. Alternatively, the possibility remains that macaw feathers—and not the birds themselves—were the most significant product that Paquimé exported, as has been suggested by Somerville et al. (2010). Feathers could have been procured *en masse* from birds kept in the Casas Grandes region and then transported to other parts of the SW/NW, which would have resulted in the physical remains of the birds remaining at Paquimé upon death.

This study supports the presence of an alternative center of scarlet macaw breeding in the SW/NW, as was suggested by George et al. (2018). Bird keepers at Paquimé supplemented the local scarlet macaw population with birds from settlements located within the Casas Grandes region, and perhaps from elsewhere in the SW/NW. This is not a new suggestion, as researchers (Minnis et al. 1993) have pointed out that macaw cage stones have been found at other settlements within the Casas Grandes region. Though none of these settlements has yet to produce similar quantities of macaw cage stones or physical remains of scarlet macaws as Paquimé, this study suggests that local settlements also participated in macaw aviculture. Some birds that ended up at Paquimé may also have come from more distant parts of the SW/NW. One of these settlements, either in the Casas Grandes region or from elsewhere in the SW/NW, may have contained the breeding colony responsible for the genetic bottleneck observed by George et al. (2018).

Conclusions

In conclusion, I have used biogeochemistry to investigate whether scarlet macaws recovered from the site of Paquimé during the Medio period were raised and perhaps bred locally or imported from outside of the settlement. Findings from this study imply that Paquimé's population of scarlet macaws was both self-sustained and continuously supplemented through the importation of additional birds. However, $^{87}Sr/^{86}Sr$ values from macaw bone tissue suggest that imported birds were from relatively nearby Casas Grandes region settlements or perhaps elsewhere in the SW/NW, instead of the endemic habitat of scarlet macaws far to the south. This finding aligns with recent isotopic (Somerville et al. 2010) and genetic (George et al. 2018) investigations into scarlet macaws recovered from settlements in the SW/NW and contradicts models of SW/NW and Mesoamerican interaction that suppose distant procurement as the primary means for macaw acquisition (e.g., Gilman et al. 2014, 2019). This finding also supports Plog et al.'s (2021) suggestion that the pre-1250 macaw breeding center in the SW/NW inferred by George et al. (2018) is located in northern Mexico, specifically in the vicinity of Paquimé.

Findings from this study enhance our knowledge of pre-Hispanic exchange in the SW/NW by providing a baseline with which to compare other instances of macaws found contemporaneously at SW/NW settlements. Similar radiogenic strontium isotope analyses of scarlet macaw remains at SW/NW settlements dating between 1200 and 1450 CE will help to assess the role of Paquimé as a mercantile center (Di Peso 1974; Kelley and Kelley 1975) vs. ritual center (Whalen 2003) in the greater SW/NW. Additional ancient DNA analysis of Paquimé's scarlet macaw population will provide insight into the relatedness of Paquimé's macaw population to those observed in Chaco Canyon, in the Mimbres region, at Wupatki, and elsewhere. Finally, this study attests to the significance of animals in the lives of pre-Hispanic peoples and illustrates the importance of future social zooarchaeological studies that examine similar questions through various taxa (Bishop and Fladd 2018; Hill 2002; Schwartz 2018).

Chapter 4:

SCARLET MACAWS, LONG-DISTANCE EXCHANGE, AND PLACEMAKING IN THE U.S. SOUTHWEST AND MEXICAN NORTHWEST, CA. 900-1450 CE

Christopher W. Schwartz

Introduction

Exchange—defined as a two-way interaction amongst distinct social or political units (Earle 1982:2; Helms 1993:92; Oka and Kusimba 2008:341-342)—is a fundamental human behavior pursued across time and space (Algaze 1989; Ericson and Earle 1982; Ericson and Baugh 1993; Hirth 2016; Horan et al. 2005). Whether social, economic, informational, or material in nature, exchange structured past human interactions and continues to impact our interactions in an increasingly globalized world (Jennings 2010; Oka and Kusimba 2008). Though past networks were not as extensive as they are today, archaeological evidence suggests people created and maintained networks capable of moving objects thousands of kilometers (Jennings 2010). Given the challenges associated with moving objects over long distances in the past, this would have required the mobilization of vast resources (Malville 2000; Chapter 2). In this paper, I explore the dimensions of rare, non-local objects that gave them significance in local contexts to answer why past people acquired these objects and how they had transformative local impacts.

Despite a growing body of research on exchange in North America, explanations for long-distance exchange—especially among parts of Mesoamerica and the US Southwest and Mexican Northwest (SW/NW)—often fail to account for complex human behaviors observed in the archaeological record. Recently, some researchers (e.g, Crown 2016; Hosler 1994; Hedquist 2017) have sought to bring together the material, ideological, physical, and chemical properties of widely traded goods to better understand their local significance and observed distributions. Rare, non-local objects and materials that humans transported through long-distance networks often held particular significance—as animated sources of supernatural, ideological, and/or political power—that contributed to unique patterns of acquisition, exchange, and treatment (Helms 1993). Brilliantly colored iridescent scarlet macaws (*Ara macao*) native to southern Mexico and Central America but found over 1,500 km to the north in the SW/NW are a particularly engaging example of rare, distantly acquired objects. Given the presence of hundreds of macaws in the SW/NW; evidence for extensive feather trade and ritual sacrifice; and evidence for varying strategies of macaw procurement; detailed examination of scarlet macaws can help archaeologists understand (1) the extent of distant interactions maintained by pre-Hispanic inhabitants of the SW/NW, (2) the materialization of worldview, (3) complex economic behaviors associated with the procurement and/or local production of non-local objects, and (4) change or stability in economic and ritual practices over time (Creel and McKusick 1994; Gilman et al. 2014, 2019; Minnis et al. 1993; Somerville et al. 2010; Vokes and Gregory 2007).

The discoveries of scarlet macaws at various major regional centers in the SW/NW suggest that macaw acquisition and use formed an integral part of placemaking

(Figure 11). Though military macaws (*Ara militaris*) and thick-billed parrots (*Rhynchopsitta pachyrhyncha*) were recovered at archaeological sites in the SW/NW and could have been procured from closer locales, higher quantities and a pervasive distribution suggest that past people preferred scarlet macaws (Blake 1953:192; Crown 2016; Gilman et al. 2014; Greiser 1995). Evidence for large-scale aviculture has been identified at the site of Paquimé in northwestern Chihuahua, where the remains of over 300 scarlet macaws were documented (Di Peso 1974; Di Peso et al. 1974), but revisions to the initial chronology suggest that it was not until 1200 CE at the earliest. Thus, Paquimé's local production could not explain the presence of scarlet macaws at major SW/NW regional centers as early as 600/700 CE (Hargrave 1970; Haury 1976). Watson

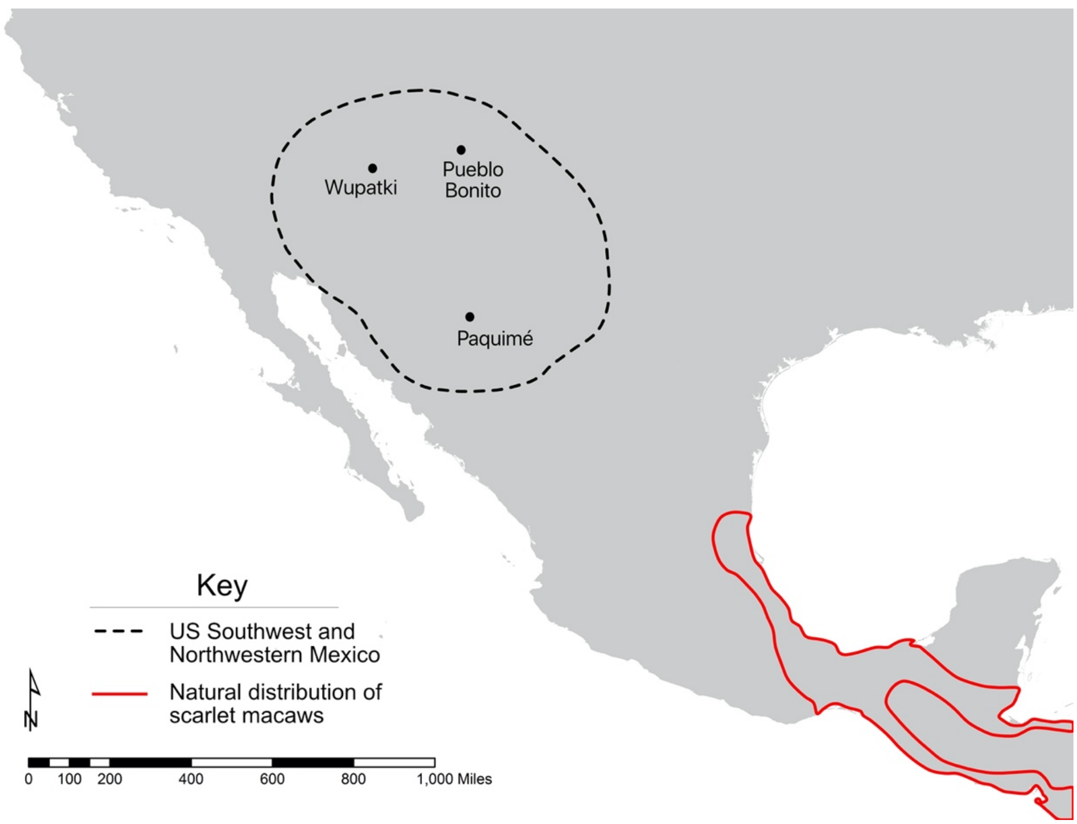


Figure 11. Pre-Hispanic distribution of scarlet macaws (*Ara macao*) in North America and three case study settlements.

et al. (2015) found that the importation of scarlet macaws at Chaco Canyon in northwest New Mexico —which might not be from southern Mexico but closer by (George et al. 2018)— preceded peaks of architectural expansion and population aggregation seen between 1040-1100 CE. They suggested that the acquisition of cosmologically and economically significant macaws, which drew on distant, exotic forces in Mesoamerica, contributed to transforming elite legitimization of power, leading to the apogee of Chacoan social development. The largest quantity of macaw skeletons in the Southwest was discovered approximately 450 km west of Chaco Canyon at Wupatki Pueblo, a 12th century community that has received considerably less scholarly attention. However, the possibility remains that scarlet macaws were primarily raised locally in Chaco Canyon, at Wupatki, or elsewhere in the SW/NW, and no comparative studies have systematically explored their treatment and deposition over time in the SW/NW.

In this paper, I use a Material Histories framework (Stahl 2010), drawing also on biogeochemical and contextual analyses to explore the acquisition, treatment, and deposition of scarlet macaws at three regional centers in the SW/NW between 900 and 1450 CE. I use radiogenic strontium isotope analysis to explore whether scarlet macaws recovered from each site were locally raised or imported, and contextual analyses to examine inter- and intra-site patterns of treatment and deposition of scarlet macaws. I find variation in both procurement strategies for scarlet macaws and the treatment and deposition of scarlet macaws over time in the SW/NW. These patterns suggest that despite the prevalence of scarlet macaws in this region, they were interpreted and interacted with in distinctly local ways. Overall, variation in the acquisition and deposition of scarlet macaws indicates changing strategies for placemaking in the SW/NW between 900 and 1450 CE.

Theorizing Long-Distance Exchange

Oka and Kusimba (2008:341) define exchange as interaction among humans, and trade as the "material-economic component of exchange and hence a necessary part of any social exchange." Exchange need not be material, but involves a relationship between distinct parties whereby objects or information move from one party to another. Exchange in past societies was not a "simple commercial relationship, nor is it a noneconomic social process" but rather a multi-faceted activity from which the political-economic landscape emerged (Oka and Kusimba 2008:341). Long-distance exchange—the acquisition or procurement of objects, materials, and ideas from far away locales—allows archaeologists to understand changing systems of human social interactions over time.

Holistic approaches to understanding trade in the past incorporate the material, economic, social, and political conditions that motivate actors (Oka and Kusimba 2008:341). Ethnographically and historically, non-local objects and materials are valued for a combination of these conditions (Helms 1993, 2014; Mauss 1925; Oka and Kusimba 2008; Stahl 2008; Thomas 1991). Rare objects from distant locales are often animated with supernatural, mystical, and powerful characteristics derived from their origins in mysterious, geographically-distant realms (Carr 2005:583; Helms 1993:334). The process of acquiring, keeping, and circulating non-local objects marks their keepers as distinct from ordinary people, and can offer ritual authority and political standing (Helms

1991:110, 1993:337; Spielmann 2002). Rare, non-local objects can also be used in performances, sacrifices, dedications, and ceremonies to create social solidarity and/or legitimize the authority of leaders (Inomata 2006; Sugiyama and Lopez Luján 2007). In the absence of state-level centralized authority, public events bring people together to integrate diverse communities and establish central places. The nature of long-distance exchange often transcends purely economic transactions and can be essential to the formation and maintenance of central places. Distinguishing the interactions and characteristics of objects that give them social relevance is essential for contextualizing long-distance exchange.

It is often through the diverse interactions amongst social actors and objects, or the specific material components of an object that its meanings are constructed. Over time, objects acquire biographies in which interactions with people, events, locales, and other objects alter their meanings (Gosden and Marshall 1999; Kopytoff 1986). Malinowski's (1932) and Mauss's (1925) seminal works characterizing the Kula ring amongst Trobriand Islanders of the western Pacific highlight how specific things (i.e., shell jewelry), by virtue of their innate characteristics and biographies, came to be traded over thousands of kilometers. Material components and attributes of an object can affect the networks through which an object travels and its perceived significance in different locales (Alberti and Bray 2009; Saunders 1999). The categories (e.g., commodities, gifts) into which archaeologists place distantly acquired or exchanged objects are in practice fluid and contextually-dependent (Appadurai 1986). Thus, examination of specific characteristics, attributes, and social relations of rare, non-local material objects can clarify elements of their significance to past people.

Scarlet Macaws in the SW/NW

Scarlet macaws were and continue to be integral elements of life in the pre-Hispanic and contemporary SW/NW. Despite a distant natural habitat in eastern Mexico, at least 1,000 km away from the SW/NW, scarlet macaws figure in SW/NW indigenous cosmologies and traditional histories, ceremonial attire and prayer sticks, ceramic designs and kiva murals, and the daily lives of humans living in the past (Crown 2016; Hargrave 1970; McKusick 2001; Tyler 1991; Whiteley 2021). Scarlet macaws are rich in symbolic associations and symbolism (e.g., red, south, the sun, summer) amongst contemporary pueblos, and ethnographic and ethnohistoric evidence attests to the importance of the birds themselves and their iridescent, multi-colored feathers (Bandelier 1890; Crown 2016; Fewkes 1900; McKusick 2001; Rizo 1998; Tyler 1991; Whiteley 2021). Cushing (1896) recorded a Zuni origin story in which the Sun Priest instructed people to choose between two turquoise-colored eggs and two earth-colored eggs, each of which contained "the seeds of living things" (Whiteley 2021). From the turquoise egg came black, evil beings that filled life with labor in the winter and from the plain-colored egg came colorful scarlet macaws that spread fertility and summer. Most chose the blue egg for its beauty and upon fledging the ravens flew away "mocking our fathers" and laughing while the scarlet macaws brought those who had chosen them to the "southward summer-land" (Cushing 1896). Thus, the nation was first separated into the Macaw-people (People of Summer) and the Raven-people (People of Winter). As Whiteley (2021) points out, scarlet macaws "feature pivotally in Zuni origin stories, coinciding with the origins of social order." Though zooarchaeological researchers typically consider past animals as units of analysis, macaws in the past were both a part of nature and also agents with animate, magical properties. Thus, macaws and their feathers can be movers in origin stories, influence the movement of the sun, the fall or rain or snow, or the changing of the seasons (McKusick 2001; Tyler 1991; Watson et al. 2015).

Though scarlet macaws were native and significant to highly populated parts of greater Mesoamerica, the actual birds appear to be at least equally important to people who lived in the pre-Hispanic SW/NW. The endemic range of the scarlet macaw extends into parts of Veracruz in the Huasteca region of eastern Mexico, as well as the Yucatán Peninsula and southern Mexico which constitute the Maya region. Scarlet macaws appeared in Maya cosmology as one form of the sun deity, Seven Macaw, and occasionally at Maya settlements like Copán in Honduras, where macaws were depicted in statues and iconography (Fash 1991; Rizo 1998). Iconographic depictions of macaws extended into West Mexico (Rizo 1998), and macaw feathers were traded or exacted as tribute from various locations throughout modern-day Mexico by the Aztecs (Nelson et al. 2021). “Domestic” scarlet macaws were possibly bred in Aztec and Tarascan houses, as well as in the Cuextlan (Huasteca) region, where there are accounts of traders traveling long-distances to trade feathers with people in the north (Alcalá 2008; Nelson et al. 2021; Sahagún 2001). Ethnohistoric accounts (Alcalá 2008; Cortés 2018) even document scarlet macaws kept in Aztec and Tarascan state zoos in their capital cities. Despite strong evidence of macaw keeping throughout pre-Hispanic Mexico, the low quantities of birds excavated from archaeological sites do not match the hundreds of birds recovered from the SW/NW, an area much further in distance from the birds’ natural range (Nelson et al. 2021).

Evidence suggests that the need for scarlet macaws in the SW/NW was so great that at least one breeding pair was transported from their natural range to meet local demand in the SW/NW. Though I argue in the second chapter about the challenges involved in pre-Hispanic macaw breeding, various lines of evidence (e.g., large quantities, hundreds of macaws) suggest local raising and recent isotopic and genetic evidence indicates possible breeding of scarlet macaws at Paquimé and elsewhere. Stable carbon and oxygen isotope analyses demonstrate that Paquimé's macaw population was fed primarily maize (*Zea mays*) and matured in a dry climate—a departure from their natural diet of fruit and nuts found in the humid lowlands of Mesoamerica (Somerville et al. 2010). More recent genetic analyses demonstrate that a founding breeding pair must have existed whose offspring were distributed to settlements in Chaco Canyon, the Mimbres region of southwestern New Mexico, and elsewhere (George et al. 2018). In the study, 71% of scarlet macaws sampled from each of these settlements shared an exact mitochondrial genome and all of the ancient macaws shared a rare genetic haplogroup (Haplo6) so distinct from contemporary wild macaws that a pre-Hispanic breeding population must have existed where SW/NW people acquired macaws until the establishment of Paquimé (George et al. 2018). People could have acquired macaws from this currently unknown settlement or region prior to the establishment of Paquimé around 1250 CE, at which point macaws could have been acquired from as close as modern-day Chihuahua.

Other scholars (Gilman et al. 2014, 2019; Watson et al. 2015) have suggested that distant travel inherent in scarlet macaw acquisition from eastern and/or southern Mexico would have garnered political prestige for ritual leaders. The macaws themselves—as symbols of esoteric knowledge—and the knowledge of their care and ceremonial use would have conferred authority on individuals capable of traveling to distant, mysterious parts of Mesoamerica (Gilman et al. 2014). Studies of present-day macaws indicate that down-the-line exchange (i.e., trade amongst intermittent locations between origin and destination) would be impossible given the many challenges associated with macaw raising and transport (Crown 2016; Gilman et al. 2014, 2019; McKusick 2001; Watson et al. 2015; Chapter 2). Overall, past people could have pursued various strategies for the acquisition of scarlet macaws in different times and places. Local breeding, local raising, importation, and/or distant acquisition could have been employed by local communities to acquire macaws, with different implications for human-macaw relationships. Thus, it is essential to assess how people acquired the birds, and how they treated and deposited birds in order to understand the local significance of scarlet macaws in placemaking at SW/NW regional centers.

Central Place Making in the SW/NW, ca. 900-1450 CE

Despite large-scale population movements and shifts in centers of rapid population aggregation between 900 and 1450 CE throughout the SW/NW, archaeologists have not identified consistency in placemaking practices. By central places, I refer to regional population centers typically characterized by relatively large-scale construction with public, socially integrative forms of architecture (Hegmon 1989; Peeples 2011; Schwartz 2018) that induce emulation (Whalen and Minnis 2001a; 2001c; 2009), high room counts relative to surrounding settlements, and evidence of integrative ritual/ceremonial practices. Examples of central places include all three of the case studies presented here, as well as Pueblo Grande in the Phoenix Basin of Arizona (Abbott 2003), Cerro de Trincheras in northern Sonora (McGuire and Villalpando 2007, 2013; Nelson 2007), and La Quemada in the Malpaso Valley of Zacatecas (Nelson 1995). Similarities in architectural forms, human behaviors, and material culture at central places in the SW/NW indicate that elements of shared placemaking occurred through time and across space. Watson et al. (2015) argue that the importation of scarlet macaws prior to the peak of architectural expansion (1040-1110 CE) at Pueblo Bonito—the largest of the Chaco Canyon great houses—was one key factor in the emergence and maintenance of social complexity at the site. In contrast, the Zuni (Cibola) region apparently flourished without scarlet macaws—or other non-local objects common to other parts of the SW/NW like copper bells—even though it appears to have been a central part of exchange networks that connected Chaco Canyon to the southern SW/NW (Vokes and Gregory 2007). The question of how rare and non-local objects were acquired and used in the process of placemaking has not yet been considered at other regional centers in the SW/NW though it has the potential to inform our understanding of mechanisms of social aggregation and the local relevance of acquiring non-local objects.

The presence of scarlet macaws at many regional centers between 900 and 1450 CE and their social, economic, ritual, and cosmological significance throughout the SW/NW suggest that they were an essential element of region-wide social aggregation and establishment of central places. At Pueblo Bonito (900-1150 CE) in northwestern New Mexico, the acquisition of scarlet macaws was associated with the emergence of societal complexity (Watson et al. 2015). This massive, 650 room settlement is located amongst the architecturally unique, multi-storied masonry great houses for which Chaco

Canyon is noted. Pueblo Bonito sat at the center of diverse and expansive long-distance exchange networks, complex road and irrigation systems, and a system of settlements expanding throughout the entire northern SW/NW that emulated the Chacoan architectural style (Lekson 1999; Kantner and Mahoney 2000; Marshall et al. 1979; Mathien 1993; Van Dyke 2007; Vokes and Gregory 2007; Watson et al. 2015). Excavations at Pueblo Bonito recovered at least 35 macaws, 31 of which have been identified as scarlet macaws, representing the largest collection of scarlet macaws north of Paquimé (Hargrave 1970; Plog et al. 2021). In addition to scarlet macaws, Pueblo Bonito incorporated elements of Mesoamerican architecture, as well as objects and material types not seen elsewhere in the SW/NW such as cylindrical cacao vessels, that indicate Chaco's centrality in establishing and maintaining long-distance exchange networks in the SW/NW (Crown and Hurst 2009; Crown et al. 2015; Mathiowetz 2018; Nelson 2006).

Wupatki, a 100-room pueblo located in the northern Sinagua region of north-central Arizona, appears to have drawn heavily on long-distance exchange during its ascent to regional center between 1080-1220 CE (Downum 1988; Stanislawski 1963; Vokes and Gregory 2007; Wilcox 2002). It was inhabited immediately following the eruption of Sunset Crater likely between 1080 and 1090 CE (Elson et al. 2007; Elson et al. 2011; but see Downum 1988 and Hevly et al. 1979 for an alternative date range for Sunset Crater's eruption), at which point migrants entered the region seeking newly arable land naturally mulched with volcanic ash (O'Hara 2015; but see Pilles 1979, 1996 for an alternative explanation). Wupatki sits in a frontier zone between the larger Chaco and Hohokam regional systems, which may explain the mix of architectural styles, material culture, and structures characteristic of both systems (O'Hara 2015; Stanislawski 1963; Wilcox 2002). Chaco-style masonry and T-shaped doorways are apparent at Wupatki and the presence of scarlet macaws, copper bells, and an unroofed great kiva suggests ties to Chaco Canyon. Moreover, the presence of a Hohokam-style ball court and *Glycymeris* shell bracelets indicate some shared connections with the Hohokam tradition to the south (Stanislawski 1963; Wilcox 2002). The adoption of both Chaco and Hohokam elements may have represented an intentional act to integrate diverse populations of migrants as they entered the region (Stanislawski 1963). Excavations at Wupatki unearthed elements from 48 individual macaws (of which at least 22 were scarlet macaws) and thick-billed parrots, the largest collection of tropical birds discovered north of Paquimé (Hargrave 1970; Stanislawski 1963).

Finally, large-scale breeding practices and ritual sacrifice of scarlet macaws at Paquimé in northern Chihuahua during the subsequent time period (1200-1450 CE) suggest economic and ritual behaviors on a larger scale than previously known to the SW/NW. Paquimé sits at the center of the Casas Grandes region and is well-known for its large site size containing unique, expansive architecture—which merges pueblo-style room blocks with traditionally Mesoamerican I-shaped ball courts and platform mounds—and immense collections of non-local materials, including copper ornaments, turquoise pieces, marine shells, and scarlet macaws (Di Peso 1974; Di Peso et al. 1974; Rakita and Cruz 2015; Whalen 2013; Whalen and Minnis 2003). Precursors to Paquimé's extensive networks of acquisition existed in the preceding Viejo Period (900-1200 CE, Searcy and Kelley 2016), but the incredible quantities of materials brought to Paquimé after 1200 CE led Charles Di Peso, the director of the Joint Casas Grandes Expedition, to suggest that Paquimé was an outpost established by Mesoamerican elites (Di Peso 1974; Minnis and Whalen 2015a). Early researchers suggested that Paquimé served as a regional trade center where non-local objects were transported from Mesoamerica into the greater SW/NW, but more recent interpretations have argued that many of the non-local objects and materials entering Paquimé were not leaving the site (Bradley 1996; Vargas 1995; Whalen 2013). Similarities with Pueblo Bonito, such as T-shaped doorways and the extensive acquisition networks that brought turquoise, copper bells, and scarlet macaws have led some to suggest that Paquimé may have been founded by descendants of people living at Pueblo Bonito (Lekson 1999). In any case, the presence of over 500 scarlet and military macaws whose skeletal remains were recovered spread across plazas and rooms, and occasionally without heads, in circular arrangements, and buried alongside humans certainly indicate an interest in large-scale aviculture and macaw-related rituals (McKusick 1974).

Applying Material Histories as a Theoretical Framework

I adopt Ann Stahl's Material Histories framework for the analysis of scarlet macaws in the pre-Hispanic SW/NW to better understand how the widespread exchange of scarlet macaws affected and was affected by human relations in the process of place making. This framework employs three complementary approaches: Biography, deposition, and genealogy. Biographical approaches explore the varied associations of objects as they circulate through contexts over time and space (Appadurai 1986; Gosden and Marshall 1999; Kopytoff 1986; Stahl 2010; Thomas 1991). Over its life course, an object sees changing associations, uses, experiences, and forms that reciprocally impact those that interact with the object and the object itself (Stahl 2010). Object biographies document and compare the phases of an object's life history by exploring the forms and associations that create and alter movement and circulations (Appadurai 1986; Stahl 2010). The emphasis on how objects shape, and are shaped by human behavior and experience allows object biographies to inform how past humans lived and experienced continuity and change. A major focus of biographical approaches—and of particular relevance to scarlet macaws—is how objects are produced in one context and re-contextualized as they are brought to another place and time (Kopytoff 1986; Thomas 1991).

Deposition refers to examining how objects are drawn together in specific contexts. This approach focuses on the ways that objects and materials with diverse origins and life courses are brought together to create meaningful relationships (Stahl 2010). The act of combining specific objects and materials creates networks of circulation that shape human behaviors and experiences (Meskell 2005; Stahl 2010). The act of deposition can vary in purpose, performance, and occurrence, and assessing its intent is central to understanding the impact on human experiences. Comparative studies of deposition in particular have allowed archaeologists to assess a range of contexts and object combinations, permitting the construction of object biographies that inform "…how object circulations produced, maintained, or disrupted social relations" (Stahl 2008).

Genealogical approaches explore how practice is reproduced and transformed over time (Joyce and Lopiparo 2005). Specifically, genealogical approaches assess how the continuity or discontinuity of objects and materials condition human behavior and foster social practice over time (Stahl 2010). Stahl (2010:156) cites practices of modifying the earth (e.g., mound construction, filling pits) as creating connections with the past while simultaneously producing social relations through building and others have highlighted the importance of earth modification in creating community and promoting acceptance of nascent social hierarchies (Bradley 1998; Clark 2004a, 2004b; Sassaman 2005). Earth modification practices are also recognized as forms of placemaking amongst Hopi people (Balenquah 2008). Ultimately, genealogical approaches focus on comparing "…commonalities and differences in human practice at sites in a region through time", typically in regions where sites are linked to living populations (as in a "direct historical approach") (Stahl 2010: 156-7).

The Material Histories framework has primarily been employed where archaeological evidence exists over long periods of time and can be combined with historical records of material adoption and use. Stahl's framework has previously been applied primarily to colonial contexts in West Africa, where Banda material interactions are produced and reproduced over hundreds of years of inhabitation and reciprocally influenced by the introduction of European colonizers and their material culture (Stahl 2001). In these contexts, the framework provides a deeper understanding of human interaction with objects/materials, the ways in which objects and people are bound in global connections, and the effect of changing socio-historical processes on perceptions and practices through the modern day.

Here, I adopt the Material Histories framework to explore the acquisition, treatment, and deposition of scarlet macaws in the establishment of three regional centers in the SW/NW. As biographical approaches, I use radiogenic strontium isotope analysis to examine macaw and parrot acquisition in all three cases, and to a lesser extent the human experience of transporting and raising scarlet macaws (for a more detailed discussion, see Chapter 2). To explore deposition, I analyze detailed contextual data to examine the treatment and depositional context of macaw and parrots in each case. Finally, I employ a genealogical approach comparing the acquisition, treatment, and deposition of scarlet macaws at Pueblo Bonito (900-1150 CE), Wupatki (1080-1220 CE), and Paquimé (1200-1450 CE) to examine continuity or change in placemaking over time and space at regional centers in the SW/NW.

Assessing Local vs. Non-Local Raising of Macaws through Radiogenic Strontium Isotope Analysis

The question of whether scarlet macaws were being raised locally at regional centers or acquired from external settlements can be assessed using radiogenic strontium isotope analysis because values of $^{87}Sr/^{86}Sr$ vary worldwide based on the age and composition of underlying bedrock (Ericson 1985, Price et al. 2002; see overview in Bentley 2006). As ^{87}Rb decays into ^{87}Sr over time, ^{86}Sr remains stable and $^{87}Sr/^{86}Sr$ ratios increase with age of bedrock (Dasch 1969; Dickin 2005). Because trace amounts of strontium substitute for calcium during bone growth, bone tissue of humans and animals consuming locally available food and water sources will reflect local bedrock $^{87}Sr/^{86}Sr$ values (Bentley 2006). Radiogenic strontium isotopes are subject to fractionation, but far less susceptible than light stable isotopes (e.g., $^{18}O/^{16}O$), and minor fractionation be normalized through mass spectrometry (Bentley 2006; Ezzo 1994; Price et al. 2002). However, natural processes such as bedrock weathering and aeolian dust can impact

$^{87}Sr/^{86}Sr$ values considered local by affecting strontium uptake in ecological systems (Bentley 2006; Burton and Hahn 2016; Knudson et al. 2014; Price et al. 2002).

In this chapter, I focus only on local $^{87}Sr/^{86}Sr$ variation and potential sources of dietary strontium for macaws in the Wupatki area, because a comparable discussion for Paquimé can be found in Chapter 3 and Pueblo Bonito will be considered in a forthcoming publication by Plog et al. For a geologically-active region like the Flagstaff area, factors such as variability in relatively young volcanic depositions and older underlying sedimentary bedrock as well as the persistent deposition of aeolian dust can impact what are considered local $^{87}Sr/^{86}Sr$ values. Wupatki National Monument sits on land that can be separated into two basic groups of bedrock: Quaternary volcanic basalt and Paleozoic/Mesozoic sedimentary rock (Figure 12; Anderson and Elson 2009). The slightly higher-elevation west side of the monument is composed of some relatively recent Quaternary volcanic flows estimated at $^{87}Sr/^{86}Sr = 0.7045-0.7059$ and the older Kaibab Formation, which is estimated near $^{87}Sr/^{86}Sr = 0.7077$ (Anderson and Elson 2009). Wupatki sits on the eastern sedimentary portion of the monument, which contains some volcanic rock near Doney Crater and overall high bedrock variability near the Black Point Monocline, which cross-cuts the monument in a north-south direction. Wupatki rests on older Paleozoic/Mesozoic formations: Older Paleozoic deposits like Moenkopi sandstone are estimated at $^{87}Sr/^{86}Sr = 0.7077-0.7094$. Because there are field houses and evidence for farming throughout the monument, a detailed examination of dietary sources of strontium in macaw diet is necessary.

Aeolian dust and volcanic ash after the eruption of Sunset Crater represent additional factors that may impact local $^{87}Sr/^{86}Sr$ signatures at Wupatki. Windblown dust

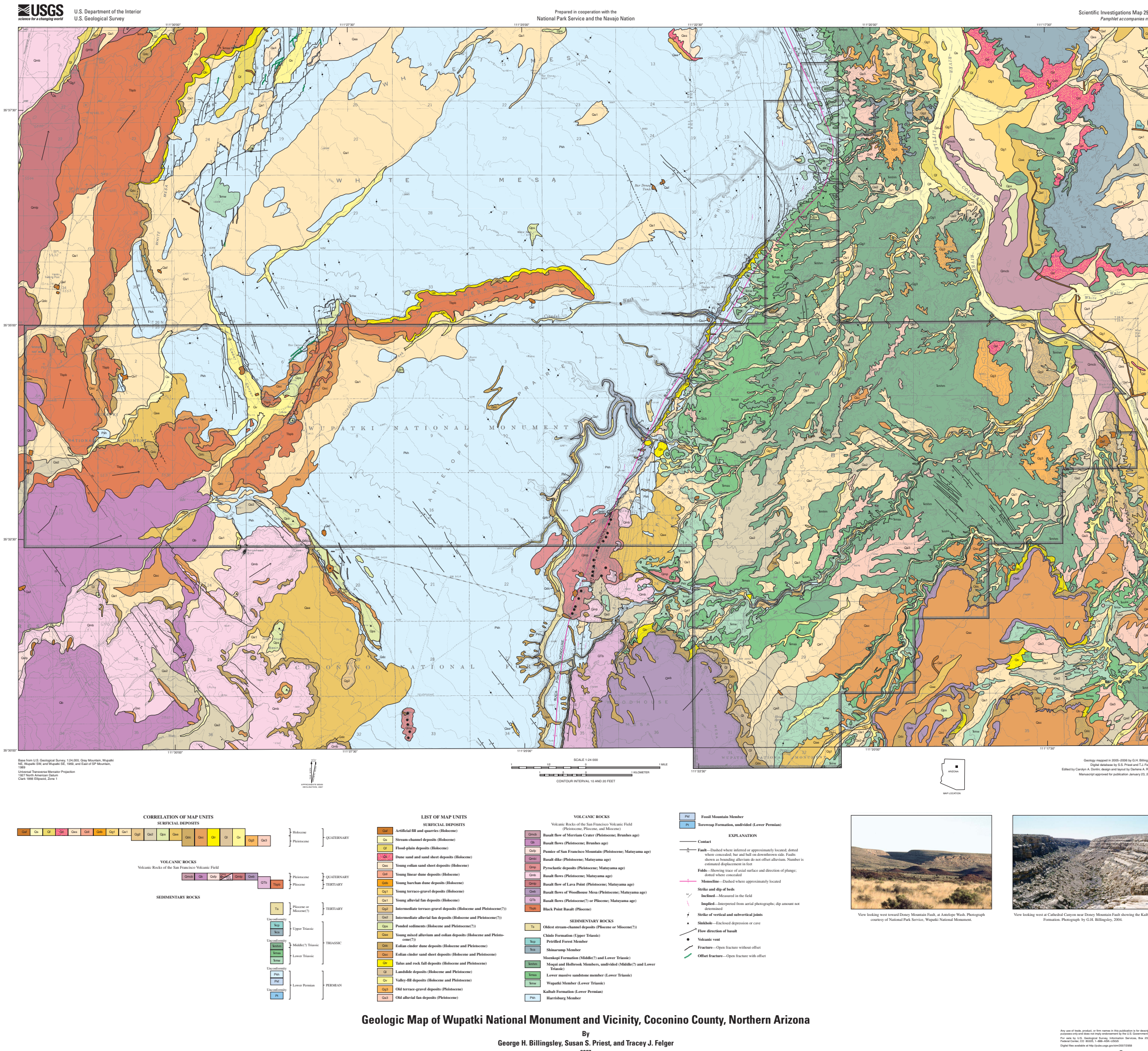


Figure 12. Geologic variation at Wupatki National Monument (from Billingsley et al. 2007).

can act as a principle source of calcium in arid environments, which results in mixing with local bedrock $^{87}Sr/^{86}Sr$ values as bedrock strontium bonds with calcium carbonate in dust (Anderson and Elson 2009:7; Bentley 2006:150). Van der Hoven and Quade (2002) found that $^{87}Sr/^{86}Sr$ values in soils on volcanic basalt flows varied with their proximity to sedimentary rocks, because of the influence of windblown dust from the sedimentary rocks. The Flagstaff area and Wupatki National Monument are particularly windy and samples of aeolian dust from this area yielded an $^{87}Sr/^{86}Sr$ value of 0.7090 (Anderson & Elson 2009). Finally, Elson et al. (2011) argued that volcanic ash fall from the eruption of Sunset Crater would have caused an overall decrease in $^{87}Sr/^{86}Sr$ values in local soils and water. As relatively young volcanic ash and rock with low $^{87}Sr/^{86}Sr$ values were deposited over the Flagstaff area landscape, mixing of cinders with soil and water would have caused local $^{87}Sr/^{86}Sr$ signatures to decrease. In a preliminary study of tree beams recovered from Wupatki, three of the four sampled indicated overall decreases in $^{87}Sr/^{86}Sr$ values between 1050 and 1095 CE (Elson et al. 2011:127-129). Although there would have been some time before migrants entered the region following the eruption and began to establish settlements (Elson et al. 2011), this newly fallen ash could have had a lasting impact on what are considered local $^{87}Sr/^{86}Sr$ values.

Sources of Strontium in Scarlet Macaw Diet

Because of the geological variability surrounding Wupatki, it is also necessary to assess expected sources of strontium in a scarlet macaw diet in order to best understand anticipated local $^{87}Sr/^{86}Sr$ signatures. Given the location of Wupatki, dietary strontium for macaws primarily came through terrestrial sources. Aquatic fish were available in the nearby seasonally-flowing Little Colorado River, but relatively few fish remains were recovered from Wupatki (n = 2 in Huffer [2013:26]; Stanislawski [1963:17] notes that "…several vertebrae of a bony-tail were found in excavated material and some portions of *Astyanax mexicanus* [*Ostariophys*], as well as some catfish, carp, and minnow remains, these mostly in Room 60b."). Agricultural features and sites make up one-half of all sites recorded in the Wupatki Archaeological Inventory Survey, indicating that local agriculture was common in the region (Anderson 1990:2-24; Travis 1990). The dispersal of cinders across the landscape meant that agriculture was possible throughout most of the surrounding area (Anderson 2011; Colton 1932, 1946, 1960; Elson et al. 2011). High density of agricultural features across Antelope Prairie (northwest of Wupatki, approximately 15 km) indicate farming occurred in this area, which is underlaid by the older Kaibab Formation (Figure 2; Billingsley et al. 2007). Additional field houses and rock alignments meant to collect water prevent erosion were observed on lava flows at Doney Crater, approximately 3 km from Wupatki.

At Paquimé, Somerville et al. (2010) found the diet of scarlet macaws to be made up of hand-fed maize. The same was probably true at Wupatki, where evidence of corn kernels and cobs suggest that maize was a staple crop (Anderson 1990; Stanislawski 1963). Various species of beans (*Phaseolus lunatus*, *Phaseolus vulgaris*, *Phaseolus acutifolius*) were also recovered from Wupatki and nearby settlements (Anderson 1990; Bartlett 1934:66-67; McGregor 1941:261; Smith 1952:35; Stanislawski 1963:466). Given that maize kernels have relatively low strontium concentrations, beans and other locally-available food resources like juniper berries (*Juniperus monosperma*) and squash seeds (*Cucurbita moschata*, *Cucurbita pepo*, and *Cucurbita mixta*), which have been recovered from archaeological contexts at Wupatki, may have contributed to scarlet macaw diets.

Consumable seeds and nuts, such as mormon tea (*Ephedra viridis*), goosefoot (*Chenopodium album*), pigweed (*Amaranthus albus*), and piñon nuts (*Pinus monophylla*) were also available to people living near Wupatki, though piñon trees are rare today, perhaps due to woodcutting by pre-Hispanic peoples (Anderson 1990).

Water sources for the pre-Hispanic inhabitants of Wupatki probably came primarily from local springs, rainfall, and snowfall. At least five local springs have been recorded at the base of Woodhouse Mesa very close to Wupatki, and the seasonally flowing Little Colorado River is located approximately 15 km away (Anderson 1990:3-12). The Woodhouse Mesa springs issue from the Moenkopi Formation indicating higher $^{87}Sr/^{86}Sr$ values consistent with older geologic deposits (Christensen 1982:72). Geologic activity (e.g., fissures, cracks) underlying Wupatki may have impacted the availability of these springs and some springs may not have been consistently available, leading to a diversification of water collection techniques (Anderson 1990:3-15; Miller 1962:24). The Wupatki Archaeological Inventory Survey also observed dams and reservoirs, catchments, and check dams on the landscape (Anderson 1990). Additional techniques to preserve water would include collecting water in jars under ledge overhangs (Schroeder 1944), collecting runoff from the roofs of dwellings, or collecting and melting snow (Anderson 1990:3-14).

The consumption of clay and soil, or geophagy, has also been observed in scarlet macaw populations in South America. A study by Brightsmith et al. (2018) found that peak clay-lick use by wild Peruvian macaws coincides with breeding seasons, supporting the hypothesis that geophagy was practiced during times of when extra minerals are needed to support egg formation and chick growth. Though most of the Wupatki macaws that could be aged were not in stages of chick growth (neonate-, hatchling-, or fledgling-aged) or of breeding age, it is still possible that birds were consuming soils, especially if they were kept in enclosed rooms (Hargrave 1970). Additionally, macaws often use their beaks to move themselves around and constantly pick at their surroundings (Chapter 2), which might have the unintentional effect of consuming soils. High concentrations of strontium in soils would incorporate $^{87}Sr/^{86}Sr$ values indicative of materials used in construction—such as plasters and adobe used in floors and walls—in the Wupatki macaw population, if those birds were primarily kept in room contexts. Birds allowed to fly freely (Chapter 2), might have more variable $^{87}Sr/^{86}Sr$ values.

Methods and Materials

Sampling Strategy: Radiogenic Strontium Isotope Analysis

Scarlet macaw bone samples listed in Table 1 were selected from archaeological collections housed at the Museum of Northern Arizona in Flagstaff, Arizona. In total, 15 bones were selected (humerus n = 10; coracoid n = 2; radius n = 1; tarsometatarsus n = 1; ulna n = 1) from 14 macaws at varying ages at death and one thick-billed parrot. This represents 31.3% of the total macaw and parrot population recovered at Wupatki. An attempt was made to include a range of ages at death but ultimately bones samples were selected based on availability. Well-preserved long bones were preferentially selected because denser cortical bone is expected to better preserve biogenic strontium signals and bone turnover occurs more slowly than in less dense bones (Somerville et al. 2010). Because bone turnover is estimated at a half life of >600 days and all individuals that could be aged were assigned immature (4-11 months) and newfledged (11-12 months)

Table 4. Contextual information, elemental concentration, and isotope data from archaeological scarlet macaw (*Ara macao*) samples from Pueblo Bonito, Wupatki, and Paquimé analyzed in this study.

Sample No.	Spec. No.	Provenience	Species	Age	Bone	Ca/P	U/Ca	$^{87}Sr/^{86}Sr$
Pueblo Bonito (New Mexico, USA) [n = 8 archaeological fauna, average = 0.7093, SD = 0.0003, local range = 0.7090 - 0.7097]								
PB78	NMNH 343578	Room 249	Ara macao	Adolescent	--	--	--	0.7093
PB83	NMNH 343583	Kiva J	Ara macao	Newfledged	--	--	--	0.7091
Wupatki (Arizona, USA) [n = 8 modern plants, average = 0.7078, SD = 0.0004, local range = 0.7070 - 0.7085]								
ACL-11226	WUPA 7376	B.11.1	Ara macao	Immature	Humerus	2.25	9.29E-07	0.70805
ACL-11227	WUPA 7377	Room 43	Ara macao	Newfledged	Humerus	2.20	2.98E-07	0.70816
ACL-11228	WUPA 7378	Unknown	Ara macao	Newfledged	Humerus	2.26	2.28E-06	0.70838
ACL-11229	WUPA 7379	Room 63	Ara macao	Newfledged	Humerus	2.35	8.36E-07	0.70824
ACL-11230	WUPA 7380	B.8.1	Ara macao	Newfledged	Humerus	2.21	4.14E-07	0.70801
ACL-11231	WUPA 7381	Unknown	Ara sp.	Unknown	Humerus	2.29	1.44E-06	0.70779
ACL-11232	WUPA 7384	Room 48	Ara macao	Immature	Humerus	2.30	4.75E-07	0.70839
ACL-11233	WUPA 7382	Room 35C	R. pachyrhyncha	Unknown	Humerus	2.14	2.81E-07	0.70736
ACL-11234	WUPA 7388	B.10.1	Ara macao	Unknown	Humerus	2.24	1.99E-07	0.70819
ACL-11235	WUPA 7395	Room 41	Ara sp.	Unknown	Radius	2.40	7.26E-06	0.70831
ACL-11236	WUPA 7397	General Screening	Ara macao	Unknown	Coracoid	2.25	7.18E-07	0.70823
ACL-11237	WUPA 7398	Room 41	Ara macao	Unknown	Humerus	2.38	8.97E-08	0.70816
ACL-11238	WUPA 7403	M.258	Ara macao	Unknown	Tarsometatarsus	2.21	6.05E-06	0.70823
ACL-11239	WUPA 7407	General Screening	Ara macao	Newfledged	Ulna	2.24	3.21E-07	0.70822
ACL-11240	WUPA 7413	General Screening	Ara sp.	Unknown	Coracoid	2.26	4.24E-07	0.70822
Paquimé (Chihuahua, México) [n = 10 archaeological fauna, average = 0.7072, SD = 0.0001, local range = 0.7068 - 0.7075]								
ACL-0812	CG-240	Plaza 3-12	Ara macao	Immature	Humerus	1.95	4.15E-07	0.70725
ACL-0813	CG-227	Plaza 3-12	Ara macao	Newfledged	Femur	1.94	5.00E-06	0.70741
ACL-0814	CG-49	Room 36-11	Ara macao	Adult II	Humerus	1.91	6.97E-08	0.70760
ACL-0815	CG-237	Plaza 3-12	Ara macao	Immature or older	Humerus	1.92	1.64E-06	0.70784
ACL-0816	CG-272-3	Plaza 3-12	Ara macao	Immature	Femur	1.93	6.96E-07	0.70728
ACL-0817	CG-258	Plaza 3-12	Ara macao	Immature	Humerus	1.93	9.40E-07	0.70799
ACL-0818*	CG-68	Plaza 6-12	Ara macao	Immature	Tibiotarsus	1.98	9.19E-06	0.70740
ACL-0819	CG-46	Room 36-11	Ara macao	Immature	Tibiotarsus	1.85	6.28E-08	0.70821
ACL-0820	CG-0a	Plaza 3-12	Ara macao	Immature	Humerus	1.93	1.06E-05	0.70723
ACL-0821	CG-244	Plaza 3-12	Ara macao	Immature	Femur	1.91	6.24E-06	0.70779
ACL-0822	CG-364.1	Plaza 3-11	Ara macao	Immature	Femur	1.92	2.26E-06	0.70718
ACL-0823	CG-0b	Plaza 3-12	Ara macao	Nestling	Humerus	1.88	1.07E-05	0.70747
ACL-0824	CG-255	Plaza 3-12	Ara macao	Immature or older	Humerus	1.92	3.23E-06	0.70746
ACL-0825	CG-248	Plaza 3-12	Ara macao	Adult I	Humerus	1.97	2.63E-05	0.70673
ACL-0826	CG-305	Room 2-18 Platform	Ara macao	Immature	Humerus	2.14	1.74E-05	0.70775
ACL-0827	CG-89	Plaza 3-11	Ara macao	Immature	Humerus	1.92	1.28E-06	0.70744
ACL-0829	CG-325	Room (Plaza) 19-8	Ara macao	Adult II	Humerus	1.90	3.05E-06	0.70702
ACL-0830	CG-257	Plaza 3-12	Ara macao	Immature or older	Femur	1.91	9.79E-07	0.70844
ACL-0831	CG-267	Plaza 3-12	Ara macao	Immature or older	Femur	1.92	3.44E-07	0.70743
ACL-0832	CG-319	Room (Plaza) 19-8	Ara macao	Immature	Humerus	1.90	1.57E-06	0.70717
ACL-0833	CG-110	Plaza 3-12	Ara macao	Immature	Femur	1.91	1.89E-06	0.70731
ACL-0834	CG-75	Plaza 5-12	Ara macao	Immature	Femur	1.94	1.82E-06	0.70728
ACL-0835	CG-109	Plaza 3-12	Ara macao	Immature or older	Femur	1.93	2.16E-06	0.70702
ACL-0836	CG-79	Plaza 5-12	Ara macao	Immature	Humerus	1.93	8.79E-07	0.70687
ACL-0837	CG-246	Plaza 3-12	Ara macao	Immature	Femur	1.92	5.03E-06	0.70725
ACL-0838	CG-297	Room 28-8	Ara macao	Immature	Humerus	1.92	4.47E-07	0.70724
ACL-0839	CG-82	Plaza 3-11	Ara macao	Newfledged	Humerus	1.92	4.84E-06	0.70730
ACL-0840	CG-70	Plaza 6-12	Ara macao	Adult II	Humerus	1.94	5.51E-06	0.70727
ACL-0841	CG-245	Plaza 3-12	Ara macao	Immature	Humerus	1.93	6.65E-07	0.70968

Table 5. Strontium isotope results from modern plant baseline specimens from Wupatki.

Sample No.	Spec. No.	Latitude	Longitude	Elevation	Species	$^{87}Sr/^{86}Sr$
ACL-11245	WMPB005	35.53791	-111.456	1655	*Juniperus monosperma*	0.70770
ACL-11246	WMPB006	35.53791	-111.456	1655	*Oryzopsis hymenoides*	0.70744
ACL-11247	WMPB007	35.53443	-111.436	1649	*Juniperus monosperma*	0.70756
ACL-11248	WMPB008	35.53443	-111.436	1649	*Oryzopsis hymenoides*	0.70855
ACL-11249	WMPB009	35.52906	-111.415	1634	*Juniperus monosperma*	0.70737
ACL-11250	WMPB010	35.52906	-111.415	1634	*Oryzopsis hymenoides*	0.70747
ACL-11251	WMPB011	35.49586	-111.355	1489	*Atriplex canescens*	0.70787
ACL-11252	WMPB012	35.49586	-111.355	1489	*Oryzopsis hymenoides*	0.70806

Mean 0.70775 ± 0.00079 (2SD) Local Range: 0.70696 - 0.70855

age categories (Hargrave 1970; but see Crown 2016 for a critique of Hargrave's age designations), all samples represent lifetime averages of strontium intake.

Wupatki Modern Plant Baseline Selection

Modern plants were sampled to establish a local $^{87}Sr/^{86}Sr$ baseline for Wupatki (Table 2). Plant samples were selected based on similarity to potential sources of strontium in the scarlet macaw diet, proximity to Wupatki, and proximity to areas in which Wupatki's inhabitants likely farmed. Because the Wupatki National Monument itself and the surrounding National Park Service land is and has been protected since 1924 (Colton et al. 1933; Downum 1988), there were no concerns about the introduction of non-local strontium through modern fertilizers. Juniper (*Juniperus monosperma*), indian millet (*Oryzopsis hymenoides*), rabbitbrush (*Ericameria nauseosa*), and fourwing saltbush (*Atriplex canascens*) were preferentially selected as baseline samples. Juniper was selected because it was a likely food source and has relatively deep roots that will be consistent with underlying geology (Foxx et al. 1984; Krämer 1990). Indian millet was selected because it was also a potential food source and, along with rabbitbrush, exhibits root depths similar to maize and other locally-farmed foods (Benson and Grimstead 2018;

Foxx et al. 1984). Fourwing saltbush was selected for its use in Hopi maize preparation and relatively deep root depth (Foxx et al. 1984; Kavena 2016).

Sample Preparation for Elemental Concentration and Radiogenic Strontium Analyses

All preparation of Wupatki and Paquimé scarlet macaw samples for radiogenic strontium analysis occurred in the Archaeological Chemistry Laboratory (ACL) and Metal, Environment, and Trace Elemental Analytical Laboratory (METAL) at Arizona State University by Christopher Schwartz. All bone tissue was mechanically cleaned and trabecular bone was removed with a mechanical drill. Approximately 0.003g of bone was then rinsed in 5 mL of 0.8 M acetic acid and ashed for 10 hours at 800˚C in a Thermo Scientific Lindberg Blue box furnace. At METAL, trace elemental concentrations were analyzed on Thermo-Finnigan series quadrupole inductively-coupled plasma mass spectrometer (Q-ICP-MS). Biogenic strontium was then separated from the sample matrix using the PrepFAST system (Romaniello et al. 2015). The samples were then analyzed using the Neptune multi-collector inductively coupled plasma mass spectrometer (MC-ICP-MS), where strontium carbonate standard SRM-987 yielded a value of $^{87}Sr/^{86}Sr = 7.10264 \pm 0.000014$ (2σ, n = 27) and $^{87}Sr/^{86}Sr = 7.1025 \pm 0.000015$ (2σ, n = 20). For a more detailed discussion of radiogenic strontium isotope analysis methods, see Chapter 3. For a discussion of the preparation of Pueblo Bonito scarlet macaw samples see Plog et al. (2021).

Sampling Strategy: Contextual Analyses

To examine the deposition of scarlet macaws at Pueblo Bonito, Wupatki, and Paquimé, I examined published sources, academic and contract reports, and archival sources at the Museum of Northern Arizona (MNA). Reports by Hargrave (1970) and

McKusick (1974) on macaws in the SW/NW and at Paquimé, respectively, laid the ground work for contextual data collection here, and I draw heavily on both of these works. In my discussion of the deposition of Pueblo Bonito macaws and parrots, I draw on the recent work by Bishop (2019), Bishop and Fladd (2018), and Plog et al. (2021). Data collection at the MNA provided access to a number of rare reports about Wupatki, including those from the 1933 MNA excavations (Colton n.d.), 1933-1934 Civil Works Administration (CWA) excavations (Colton et al. 1933), and 1952 excavations associated with stabilization of Wupatki (Richert 1952). Raw contextual data collected for macaws and parrots examined in this study are reported in Appendix B.

Biography: Radiogenic Strontium Isotope Analysis of Macaw and Parrot Remains

Pueblo Bonito

Mean archaeological macaw bone strontium isotope values from Pueblo Bonito are $^{87}Sr/^{86}Sr = 0.70921 \pm 0.00020$ (2σ, n = 2). They range from $^{87}Sr/^{86}Sr = 0.70914$ to $^{87}Sr/^{86}Sr = 0.70928$ (Table 4, Figure 13). Elemental concentrations of calcium, phosphorus, and uranium in Pueblo Bonito macaw bone tissue do not indicate diagenetic contamination, but are not discussed here as they are to be available in a forthcoming publication (Stephen Plog, personal communication 2020). Likewise, archaeological fauna baselines sampled from Pueblo Bonito are consistent with radiogenic strontium analyses done in the Chaco Canyon region, but are not reported here, as they will be available in a forthcoming publication (Stephen Plog, personal communication 2020). The Pueblo Bonito baseline local range is set at $^{87}Sr/^{86}Sr = 0.70901$ to $^{87}Sr/^{86}Sr = 0.70968$ ($^{87}Sr/^{86}Sr = 0.70935 \pm 0.00034$ [2σ, n = 8]) and reported in Table 4.

Two scarlet macaws from Pueblo Bonito were available for study and both specimens exhibit $^{87}Sr/^{86}Sr$ values indicative of a local origin. While this represents only a small subsample (5.7%) of the total scarlet and indeterminate macaw population from Pueblo Bonito, it suggests that macaws kept at Pueblo Bonito were actively being kept and locally raised by the site's inhabitants.

Wupatki

Mean archaeological macaw bone strontium isotope values from Wupatki are $^{87}Sr/^{86}Sr = 0.70818 \pm 0.00031$ (2σ, n = 14). They range from $^{87}Sr/^{86}Sr = 0.70779$ to $^{87}Sr/^{86}Sr = 0.70839$ (Table 4, Figure 14). One thick-billed parrot from Wupatki was also sampled and its $^{87}Sr/^{86}Sr$ value is 0.70736. Elemental concentrations of calcium, phosphorus, and uranium indicate little diagenetic alteration of bone tissues sampled here: Mean Ca/P = 2.27 ± 0.14 (2σ, n = 15) and mean U/Ca = $1.47 \times 10^{-6} \pm 4.38 \times 10^{-6}$ (2σ, n = 15). Overall, Ca/P values are at or slightly above the expected human apatite ratio of 2.1:1 (Price et al. 1992) and all samples fall within the expected range of Ca/P values in modern humans (2.17 ± 0.31 [1σ, n = 78]) reported by Zaicheck and Tzaphlidou (2002). Additionally, U/Ca ratios are similar to those reported by Knudson et al. (2014:315) in uncontaminated human bone and enamel (U/Ca = $4.22 \times 10^{-6} \pm 6.39 \times 10^{-6}$ [2σ, n = 14]) and those for uncontaminated faunal bone and enamel (U/Ca = $1.74 \times 10^{-7} \pm 1.29 \times 10^{-7}$ [2σ, n = 9]). Modern plant baseline data are presented in Table 2. The Wupatki baseline local range is set at $^{87}Sr/^{86}Sr = 0.70696$ to $^{87}Sr/^{86}Sr = 0.70855$ ($^{87}Sr/^{86}Sr = 0.70775 \pm 0.00079$ [2σ, n = 8]).

All (n = 15) macaw and parrot specimens from Wupatki fall within the $^{87}Sr/^{86}Sr$ local range (Figure 14, Table 5), indicating that these specimens were primarily locally-

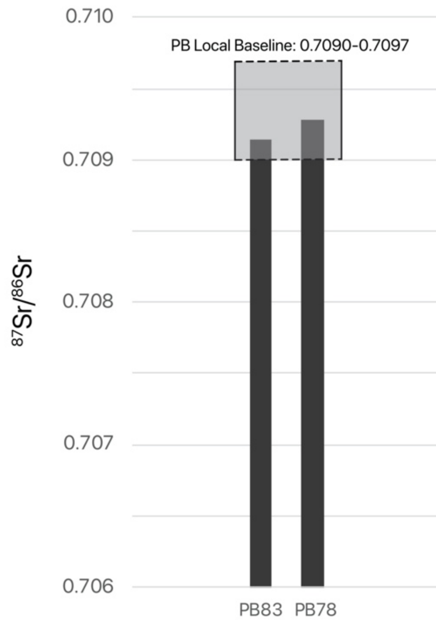


Figure 13. $^{87}Sr/^{86}Sr$ values for two archaeological macaw and parrot remains from Pueblo Bonito. Local $^{87}Sr/^{86}Sr$ baseline for Pueblo Bonito in grey.

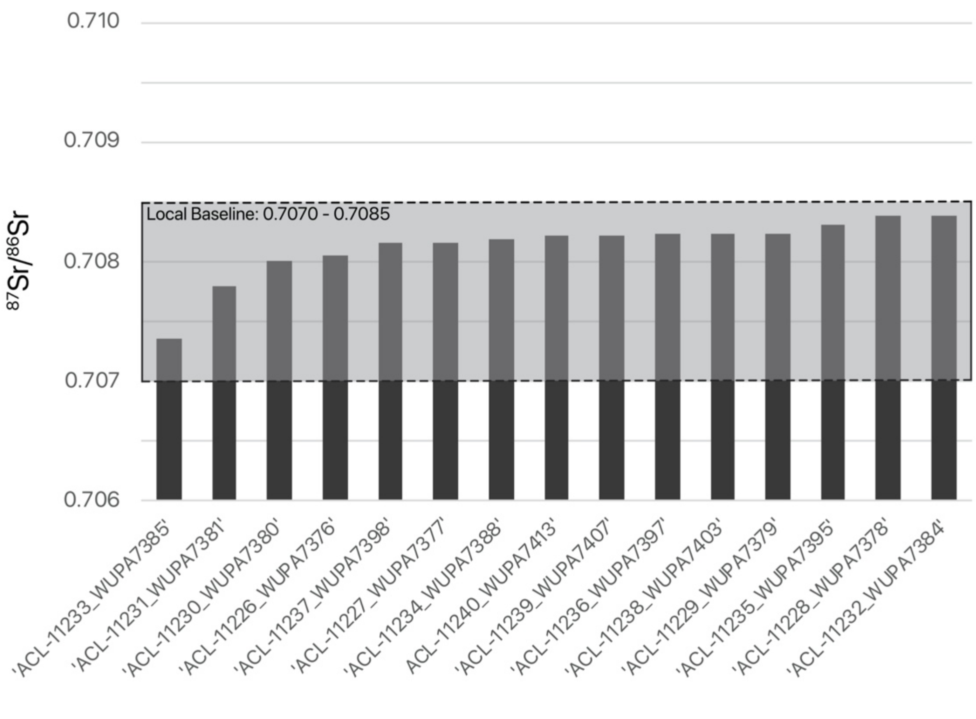


Figure 14. $^{87}Sr/^{86}Sr$ values for 15 archaeological macaw and parrot remains from Wupatki. Local $^{87}Sr/^{86}Sr$ baseline for Wupatki in grey.

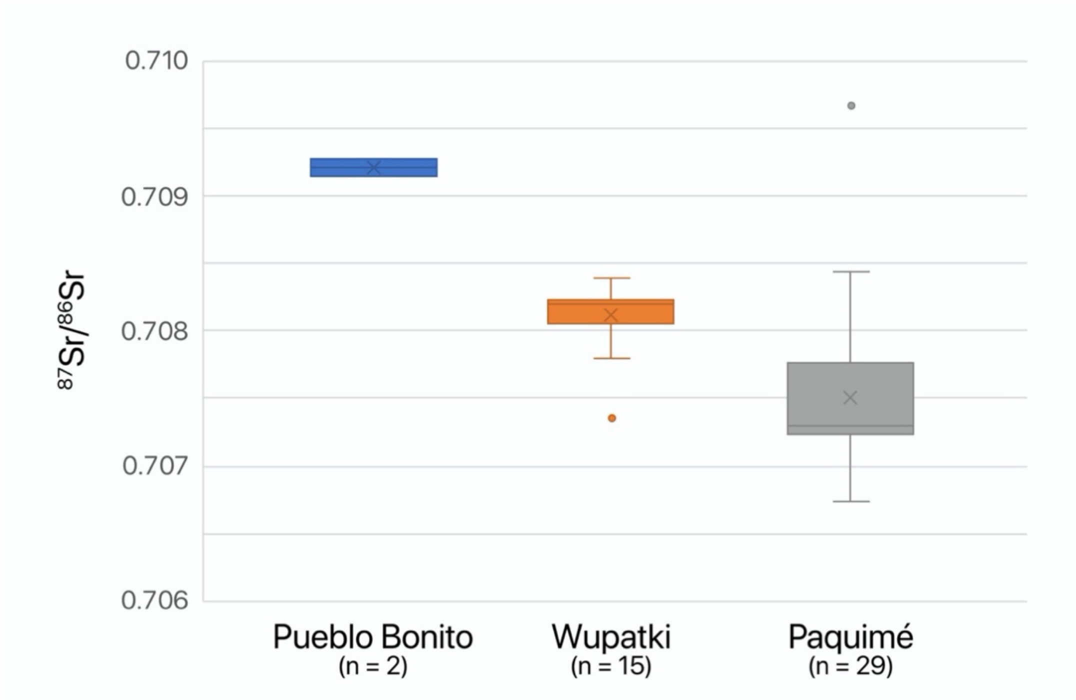


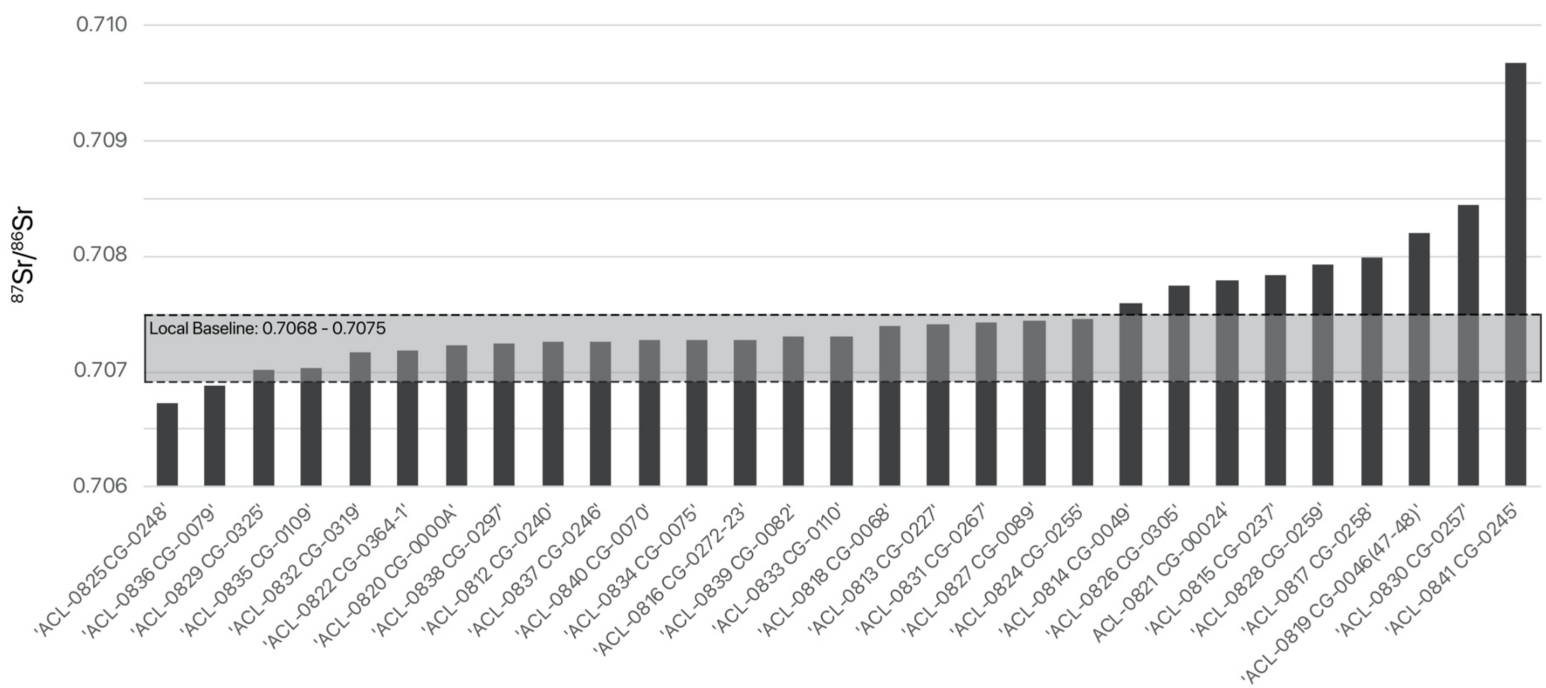
Figure 15. Boxplot of $^{87}Sr/^{86}Sr$ values in macaw bone tissue from all three case studies.

raised at Wupatki. Macaw $^{87}Sr/^{86}Sr$ values are remarkably uniform (Figure 15), suggesting that while being raised locally, these macaws were fed very similar diets. Interestingly, the one thick-billed parrot specimen (ACL-11233, WUPA7385) exhibits a lower $^{87}Sr/^{86}Sr$ signature than the relatively uniform $^{87}Sr/^{86}Sr$ values of the macaw specimens. Despite the distant origins of scarlet macaws, specimens recovered from Wupatki appear to have been kept and raised locally.

Paquimé

Mean archaeological macaw bone strontium isotope values from Paquimé are $^{87}Sr/^{86}Sr = 0.70751 \pm 0.00113$ (2σ, n = 29) (Figure 16). They range from $^{87}Sr/^{86}Sr = 0.70687$ to $^{87}Sr/^{86}Sr = 0.70968$ (Table 4, Chapter 3). Elemental concentrations of calcium,

Figure 16. $^{87}Sr/^{86}Sr$ values for 29 archaeological scarlet macaw remains from Paquimé. Local $^{87}Sr/^{86}Sr$ baseline for Paquimé in grey.



phosphorus, and uranium indicate no diagenetic alteration of macaw bone tissue: Mean Ca/P = 1.93 ± 0.09 (2σ, n = 30) and mean U/Ca = $4.22 \times 10^{-6} \pm 1.151 \times 10^{-5}$ (2σ, n = 30) (for additional discussion of diagenetic contamination in this sample of scarlet macaws, see Chapter 3).

Of 29 scarlet macaw specimens sampled from Paquimé, 19 exhibit $^{87}Sr/^{86}Sr$ values indicative of a local origin. The locality of these scarlet macaw specimens is assessed through a $^{87}Sr/^{86}Sr$ local range established in Offenbecker's (2018) work on $^{87}Sr/^{86}Sr$ in human bone and teeth at Paquimé. This local range ($^{87}Sr/^{86}Sr$ = 0.7068-0.7075) is the mean ± 3σ ($^{87}Sr/^{86}Sr$ = 0.70715 ± 0.00033, 3σ, [n = 10]), and was composed of ten archaeological fauna specimens from Paquimé (Offenbecker 2018). Of the non-local specimens, one falls slightly below and six fall slightly above the $^{87}Sr/^{86}Sr$ local range. These specimens demonstrate $^{87}Sr/^{86}Sr$ values that are consistent with $^{87}Sr/^{86}Sr$ local ranges of settlements located within the Casas Grandes region of northwestern Chihuahua and may have been raised within the region and then transported to Paquimé prior to death (Offenbecker 2018; Chapter 3). Three specimens demonstrate $^{87}Sr/^{86}Sr$ values above those measured for the Casas Grandes region, one of which (ACL-0841, CG-0245) is higher than any macaw specimen sampled in this study ($^{87}Sr/^{86}Sr$ = 0.70968). I note in chapter 3 that the $^{87}Sr/^{86}Sr$ value of this specimen is consistent with $^{87}Sr/^{86}Sr$ values measured at Mimbres settlement 76 Draw (Offenbecker 2018). Overall, there is variability in macaw acquisition practices at Paquimé, indicating the site inhabitants maintained a local population by raising scarlet macaws while also acquiring them from nearby Casas Grandes settlements and elsewhere.

Table 6. Summary of contextual and depositional information from archaeological macaw and parrot specimens from Pueblo Bonito, Wupatki, and Paquimé. Contextual data from Pueblo Bonito adapted from Bishop (2019) and Table 1 in Plog et al. (2021). ND denotes "No Data".

Taxa	Count	Completeness	Location	Context
Pueblo Bonito (New Mexico, USA) [n = 37 scarlet macaws, indeterminate macaws, & thick-billed parrots]				
Scarlet macaw	1	Whole	Room 71	Floor contact
Macaw	1	ND	Room 71	Floor contact
Scarlet macaw	1	Whole	Room 78	Floor contact
Scarlet macaw	1	Whole	Room 78	Trash
Scarlet macaw	2	Partial	Room 251	ND
Macaw	1	Partial	Room 255	Fill above floor
Scarlet macaw	1	Whole	Room 306	Subfloor pit
Scarlet macaw	3	Partial	Room 306	Subfloor pit
Thick-billed parrot	1	Whole	Room 308	Floor contact
Scarlet macaw	1	Whole	Room 309	Floor contact
Scarlet macaw	1	Partial	Kiva J	ND
Macaw	1	Partial	Kiva J	ND
Scarlet macaw	2	Partial	Room 249A	Floor contact
Scarlet macaw	2	Whole	Room 249A	Floor contact
Macaw	1	Partial	Room 249A	Floor contact
Scarlet macaw	2	Whole	Room 38	Subfloor pit
Scarlet macaw	12	Whole	Room 38	Floor contact
Scarlet macaw	1	Partial	East Refuse Mound	Trash
Scarlet macaw	1	Whole	East Refuse Mound	Trash
Thick-billed parrot	1	Partial	East Refuse Mound	Trash
Wupatki (Arizona, USA) [n = 48 scarlet, military, & indeterminate macaws, & thick-billed parrots]				
Scarlet macaw	1	Whole	Room 81	Fill above floor
Scarlet macaw	1	Whole	Room 80-81	Fill above floor
Thick-billed parrot	1	Partial	Room 80-81	Fill above floor
Scarlet macaw	1	Partial	Room 80-81	Fill above floor
Scarlet macaw	1	Partial	Room 73	ND
Thick-billed parrot	1	Partial: 1 element	Near Room 68	Trash
Scarlet macaw	1	Partial	Room 67	ND
Scarlet macaw	1	Whole	Room 63	ND
Macaw	1	Partial	Room 63	ND
Macaw	1	Partial: 1 element	Room 62	ND
Macaw	1	Partial: 1 element	Room 48	ND
Scarlet macaw	1	Whole	Room 48	Fill above floor
Macaw	1	Partial: 1 element	Room 43	Trash
Scarlet macaw	1	Whole	Room 43	ND
Macaw	1	Partial: 2 elements	Room 41	ND
Scarlet macaw	1	Partial: 2 elements	Room 41	ND
Macaw	1	Partial: 1 element	Room 41	ND
Scarlet macaw	2	Whole	Room 35C	Fill above floor
Macaw	1	Whole	Room 35C	Fill above floor
Scarlet macaw	1	Partial	Room 35C	Fill above floor
Thick-billed parrot	1	Whole	Room 35C	Fill above floor
Scarlet macaw	1	Partial	Room 35A-17	Fill above floor
Thick-billed parrot	2	Partial: 1 element, may be same bird as A0.543	Room 35	Fill above floor
Macaw	2	Partial: 1 element	"General screening"	ND
Macaw	1	Partial: 1 element	"Screening May 1959"	ND
Macaw	1	Partial	"Screening Jan. 1940"	ND

Taxa	Count	Completeness	Location	Context
Macaw	1	Partial	"Screening May 1939"	ND
Scarlet macaw	1	Partial: 1 element	"Screening trash heap"	Trash
Macaw	1	Partial: 1 element	"Trash heap"	Trash
Scarlet macaw	1	Partial: 1 element	"Trash heap"	Trash
Macaw	1	Partial: 1 element	"Miscellaneous trash"	Trash
Scarlet macaw	1	Partial: 1 element	"Miscellaneous trash"	Trash
Scarlet macaw	1	Partial	"Screening May 1939"	ND
Scarlet macaw	1	Partial: 2 elements	"Screening May 1939"	ND
Macaw	1	Partial	"M.177"	ND
Macaw	1	Partial: 1 element	"Trash fill, 1933"	Trash
Macaw	1	Partial: 1 element	"54.37"	ND
Macaw	1	Partial	"54.37"	ND
Military macaw	1	Partial: 1 element	ND	Trash
Macaw	1	Partial	ND	ND
Macaw	1	Partial: 1 element	ND	ND
Scarlet macaw	2	Partial	ND	ND
Scarlet macaw	1	Whole	ND	ND
Scarlet macaw	1	Partial: 2 elements	ND	ND
Paquimé (Chihuahua, México) [n = 505 scarlet, military, & indeterminate macaws, & thick-billed parrots]				
Scarlet macaw	1	Partial	Central Plaza, Pit 4	Subfloor pit
Military macaw	1	Partial	Central Plaza, Pit 4	Subfloor pit
Macaw	1	Partial	Central Plaza, Pit 5	Subfloor pit
Scarlet macaw	1	Partial	Pit House J-6	Fill above floor
Military macaw	2	Partial	Pit House R-6	Fill above floor
Macaw	1	Partial	Plaza 1-8; Burial 9 A-B-8	Fill above floor
Macaw	1	Partial	Plaza 3-8; Well Stairwell	Subfloor
Macaw	1	Partial	Room 13-8	Floor contact
Macaw	1	Whole	Room 15C-8	Fill above floor
Scarlet macaw	5	Whole	Room (Plaza) 19-8	Subfloor bird-human burial
Military macaw	1	Whole	Room (Plaza) 19-8	Subfloor bird-human burial
Scarlet macaw	1	Partial	Room (Plaza) 19-8	Subfloor bird-human burial
Macaw	3	Whole	Room (Plaza) 19-8	Subfloor bird burial
Scarlet macaw	29	Whole	Room (Plaza) 19-8	Subfloor bird burial
Military macaw	4	Whole	Room (Plaza) 19-8	Subfloor bird burial
Scarlet macaw	1	Whole	Room 28-8	Subfloor bird burial
Scarlet macaw	1	Partial	Room 28-8	Floor contact
Macaw	2	Partial	Room 35-8	Fill above floor
Macaw	1	Partial	Room 42-8	Floor contact
Scarlet macaw	1	Partial	Room A-8	Fill above floor
Macaw	2	Partial	Room A-8	Fill above floor
Scarlet macaw	1	Partial	Hallway 1-11	Fill above floor
Macaw	1	Partial	Hallway 1-11	Fill above floor
Macaw	1	Partial	Plaza 3-11	Fill above floor
Scarlet macaw	8	Whole	Plaza 3-11	Subfloor bird burial
Scarlet macaw	9	Whole	Plaza 3-11	Floor contact
Military macaw	2	Whole	Plaza 3-11	Floor contact
Macaw	1	Whole	Plaza 3-11	Floor contact
Scarlet macaw	46	Whole	Plaza 3-11	Subfloor bird burial
Macaw	7	Whole	Plaza 3-11	Subfloor bird burial

Taxa	Count	Completeness	Location	Context
Military macaw	2	Whole	Plaza 3-11	Subfloor bird burial
Scarlet macaw	2	Partial	Room 3-11	Floor contact
Military macaw	2	Partial	Room 3-11	Floor contact
Macaw	1	Partial	Room 3-11	Floor contact
Scarlet macaw	1	Whole	Room 13-11	Fill above floor
Scarlet macaw	1	Whole	Room 15-11	Fill above floor
Macaw	2	Whole	Room 15-11	Fill above floor
Scarlet macaw	2	Partial	Room 19-11	Floor contact
Macaw	1	Partial	Room 19-11	Floor contact
Scarlet macaw	4	Whole	Room 36-11	Subfloor bird burial
Macaw	2	Whole	Room 36-11	Subfloor bird burial
Scarlet macaw	1	Partial	Room 37-11	Floor contact
Military macaw	1	Partial	Room 37-11	Floor contact
Scarlet macaw	9	Partial	Room 38-11	Floor contact
Macaw	5	Partial	Room 38-11	Floor contact
Scarlet macaw	7	Whole	Room 38-11	Floor contact
Macaw	7	Whole	Room 38-11	Floor contact
Scarlet macaw	149	Whole	Plaza 3-12	Subfloor bird burial
Macaw	37	Whole	Plaza 3-12	Subfloor bird burial
Military macaw	52	Whole	Plaza 3-12	Subfloor bird burial
Thick-billed parrot	1	Whole	Plaza 3-12	Subfloor bird burial
Scarlet macaw	1	Partial	Plaza 3-12	Subfloor bird burial
Military macaw	1	Partial	Plaza 3-12	Subfloor bird burial
Macaw	1	Partial	Plaza 3-12	Subfloor bird burial
Scarlet macaw	2	Whole	Plaza 3-12	Fill above floor
Macaw	2	Whole	Plaza 3-12	Fill above floor
Scarlet macaw	12	Whole	Plaza 5-12	Subfloor bird burial
Military macaw	6	Whole	Plaza 5-12	Subfloor bird burial
Macaw	4	Whole	Plaza 5-12	Subfloor bird burial
Macaw	1	Partial	Plaza 5-12	Floor contact
Scarlet macaw	1	Partial	Plaza 5-12	Subfloor
Military macaw	1	Partial	Plaza 5-12	Subfloor
Scarlet macaw	3	Whole	Plaza 6-12	Subfloor bird burial
Macaw	1	Whole	Plaza 6-12	Subfloor bird burial
Scarlet macaw	5	Partial	Plaza 6-12; Pit 10	Subfloor pit
Military macaw	1	Partial	Plaza 6-12; Pit 10	Subfloor pit
Macaw	4	Partial	Plaza 6-12; Pit 10	Subfloor pit
Macaw	1	Partial	Plaza 6-12; Pit 7	Subfloor pit
Scarlet macaw	4	Partial	Plaza 6-12; Pit 9	Subfloor pit
Macaw	3	Partial	Plaza 6-12; Pit 9	Subfloor pit
Scarlet macaw	1	Whole	Room 17-12	Fill above floor
Military macaw	1	Whole	Room 7-13	Subfloor bird burial
Macaw	1	Partial	Plaza 4-14	Floor contact
Macaw	1	Partial	Room 41-14	Floor contact
Thick-billed parrot	1	Partial	Room 45-14	Floor contact
Scarlet macaw	1	Partial	Plaza 1-15/S Street	Fill above floor
Macaw	1	Partial	Room 30-16	Floor contact
Scarlet macaw	4	Whole	Room 31-16	Subfloor bird burial
Military macaw	2	Whole	Room 31-16	Subfloor bird burial

Taxa	Count	Completeness	Location	Context
Scarlet macaw	6	Whole	Room 2-18 Platform	Subfloor bird burial
Scarlet macaw	3	Whole	Plaza 1-21	Floor contact
Scarlet macaw	1	Partial	Plaza 1-21	Floor contact
Macaw	1	Whole	Plaza 1-21	Floor contact
Scarlet macaw	2	Whole	Near Plaza 1-21	Subfloor bird-human burial
Macaw	1	Partial	SW of Room 3-22	Fill above floor

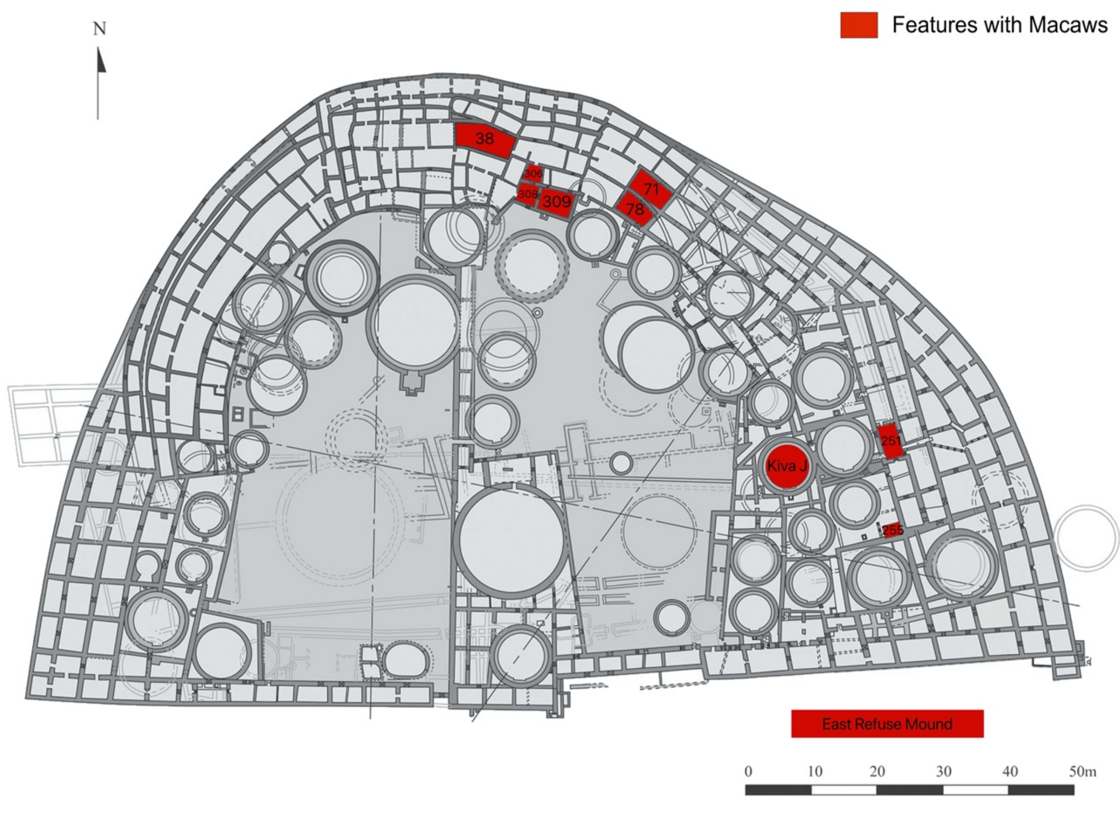


Figure 17. Locations of all macaws and thick-billed parrots recovered from Pueblo Bonito. Map adapted from Bishop and Fladd (2018).

Deposition: Contextual Analysis of Macaw and Parrot Remains

Pueblo Bonito

In total, 35 scarlet and indeterminate macaws (*Ara* sp.) and three thick-billed parrots have been recovered from Pueblo Bonito (Plog et al. 2021). Table 6 summarizes contextual information for these birds, as well as those documented from Wupatki and Paquimé, and full details can be found in Appendix B. Despite initial identification of military macaws at Pueblo Bonito, revised zooarchaeological work indicates that no military macaws have been recovered (Bishop 2019; Plog et al. 2021). No macaws or parrots recovered from Pueblo Bonito demonstrate human modifications on the bone, which indicates the birds were probably not disarticulated, or if they were great care was provided to prevent damaging any of the bones (Bishop 2019; Plog et al. 2021). The absence of rodent gnawing, root etching, and weathering on macaw and parrot remains from Pueblo Bonito—which is not true of other avian taxa—indicates that care was taken to deposit macaw and parrot remains in secure, enclosed spaces, even in the case of three birds recovered from the East Refuse Mound (Plog et al. 2021). Various pathologies were present on macaw and parrot remains (Plog et al. 2021), which may indicate aggression demonstrated amongst macaws and parrots or by their human keepers. However, pathologies observed on macaw and parrot remains are similar to those observed in other taxa, such as turkeys, which were likely kept locally (Bishop 2019; Plog et al. 2021).

Most of the macaws and parrots recovered from Pueblo Bonito were found within the older, northern arc of the great house (Figure 17). Fourteen of these birds were found within Room 38; a room that was constructed in the ninth century and has been described as an aviary that held live birds (Judd 1954:264; Pepper 1920:194; Watson et al. 2015). In addition to numerous ritually significant objects, excavation reports from Room 38 note over 20 cm of bird guano in which the birds were embedded at time of excavation (Judd 1954; Pepper 1920; Plog et al. 2021; Watson et al. 2015). Initial reports suggest that twelve of the live birds kept in this room were probably killed when the roof fell (Judd 1954:264; Pepper 1920:194). Two additional scarlet macaws were intentionally buried in Room 38 in subfloor pits in the southeastern and southwestern corners of the room. It is also probable that macaws recovered from the floor of Room 249A were killed in a roof fall event (Plog et al. 2021). Rooms 71 and 78 contained the remains of two macaws each, all of which were found in association with floors, except for one scarlet macaw recovered from the fill of Room 78 against the north wall (Bishop and Fladd 2018:300; Plog et al. 2021). Room 306 contained the remains of four macaws, one of which was placed in a pit in the northwest portion of the room and covered with stone fragments, and the commingled remains of three macaws were found in a pit that was covered by a mano in the northeast corner of Room 306 (Bishop and Fladd 2018:300-301). Two macaws were found in Kiva J, indicating a possible association with public architecture, though the depositional context of these macaws is unknown (Plog et al. 2021). The only instance of a macaw being buried with a human at Pueblo Bonito is observed in Room 309 where a scarlet macaw on the floor in the center of the room was associated with an infant burial in a southwest corner alcove (Bishop and Fladd 2018:301). Two scarlet macaws and one thick-billed parrot were recovered from extramural trash deposits in the east refuse mound, located immediately to the south of the great house. One thick-billed parrot was recovered from the floor of Room 308, where it was buried underneath a masonry pillar, perhaps as a sacrificial deposit.

The deaths of 17 of Pueblo Bonito's macaws in roof fall events indicates that live birds were kept at the site, perhaps in two restricted locales. Macaws and parrots do occur in trash deposits, but overall deposition in trash was rare. Only one macaw was deposited in association with an infant human burial, though outside of Room 33 human burials are rare in Pueblo Bonito (Akins 2001, 2003). The paucity of human burials at Pueblo Bonito, and in Chaco Canyon great houses in general, makes it difficult to assess the relationships between human and macaw burial practices. However, if mortuary treatments were similar, this may indicate "invisible" practices for macaws, like those of humans, and that the known macaw population at Pueblo Bonito is underrepresented. Bishop and Fladd (2018:301) remark that for every room in which a macaw was found in the great house, at least one of those macaws was deposited on or beneath the floor level. They interpret this pattern to suggest that macaws were "associated with the construction, occupation, or initial closure of these spaces" (Bishop and Fladd 2018:301). This pattern agrees with Watson et al.'s (2015) findings from radiocarbon dating that scarlet macaws were acquired prior to and coevally with large episodes of construction at Pueblo Bonito. The tight clustering of scarlet macaws, major concentrations of other exotic materials, and continued construction around (but not in) the northern arc of Pueblo Bonito leads Bishop and Fladd (2018:309) to conclude that inhabitants of the site had a shared memory of the significance of these spaces, which were probably "restricted to specific social groups or individuals".

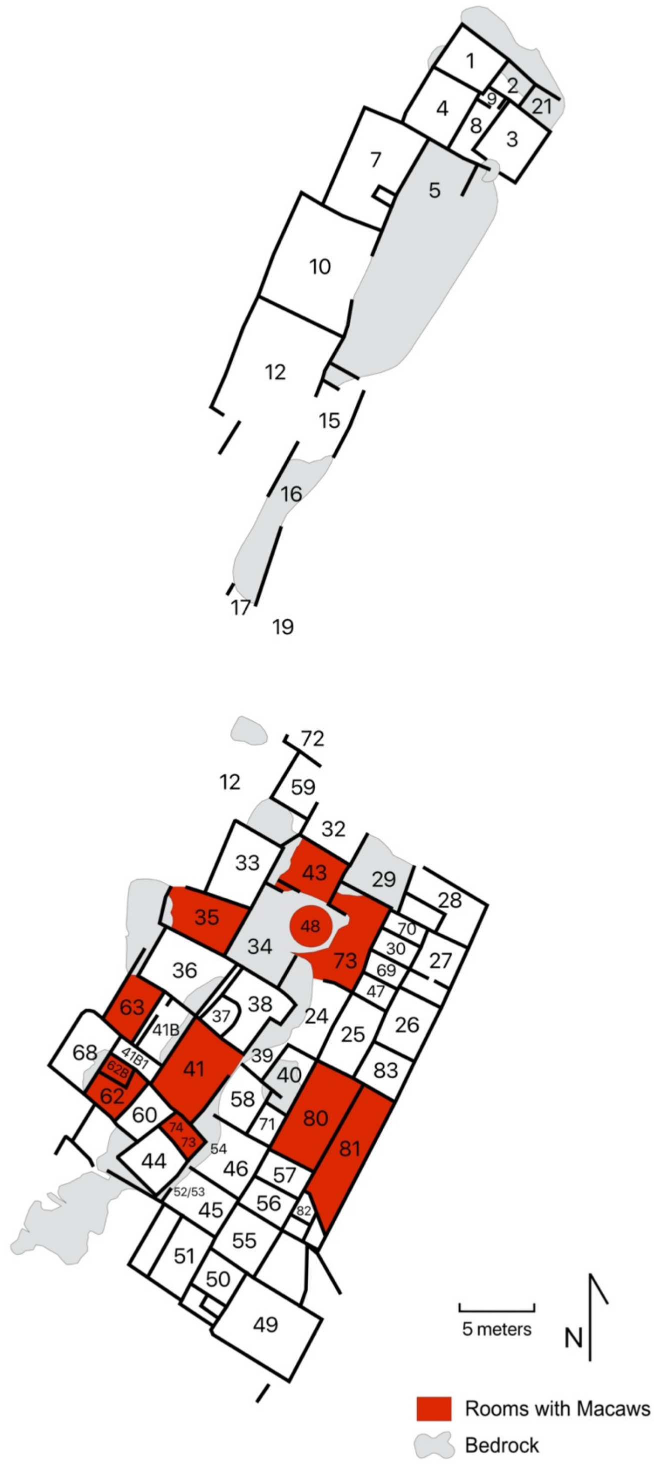


Figure 18. Locations of all macaws and thick-billed parrots recovered from Wupatki. One additional scarlet macaw (*Ara macao*) was recovered from Room 67, a hillside pithouse or storage room, located 50 meters SSW of Room 44 (Colton n.d.).

Wupatki

In total, 48 macaws and parrots have been documented at Wupatki (Table 6). Scarlet macaws constitute 22 of those individuals, 20 are indeterminate macaws, five are thick-billed parrots, and one is a military macaw. Because Wupatki's collections are divided based on the organizations that conducted the excavations, systematic zooarchaeological study has been conducted on Wupatki's tropical birds that are curated by the Western Archaeological Center (n = 3-6; Huffer 2013), while study of remains that are curated by the National Park Service and Museum of Northern Arizona is currently in progress.

In the years following its occupation, many of Wupatki's multi-story rooms collapsed on themselves (Richert 1952; Stanislawski 1963). When coupled with looting, inhabitation by sheep farmers who used the site as a temporary dwelling place, and early efforts at excavation, understanding Wupatki's inhabitation and architectural history is a complex endeavor. In contrast to Pueblo Bonito, 19 of Wupatki's macaws and parrots are represented by a single element, and four additional birds were identified by two elements. Only ten skeletons could be considered complete or nearly complete. It is difficult to say whether this is the result of early excavation methods, looting, or is actually representative of scattered deposition of macaw and parrot remains at Wupatki. Still, careful excavation of room contexts, including macaw and parrot burials have yielded important depositional information about human interactions with macaws. Hargrave (1959, 1970) noted few pathologies in his examinations of Wupatki's macaw and parrot collection, though the fragmented nature of the overall collection made this difficult to determine. In my own quick and incomplete examination of the macaw population, ulnar roughening was observed in three macaws and healing as a result of bone breakage was observed in three individuals, for a total of five macaws exhibiting pathology. One thick-billed parrot (A0.543, WUPA7382) had a badly broken ulna with healing apparent. These patterns will become clearer when zooarchaeological analyses of Wupatki's faunal collection are completed and published.

All macaws and parrots for which a context could be secured were recovered from the southern roomblock of Wupatki (Figure 18). The larger, southern roomblock exhibits earlier habitation in rooms built directly into the central rock outcropping on which Wupatki is built, and also contains a core of rooms exhibiting Chaco-style masonry (Richert 1952). Macaws and parrots were found in Rooms 35 (n = 4-8), Room 73 (n = 1), and Room 41 (n = 3), which are amongst the earliest constructed rooms at Wupatki; the latter two are part of the "Chaco core". Room 43[2] also contained two macaws, one of which was recovered in the trash fill (Hargrave 1970). Remains of multiple macaws and parrots were also recovered from external Room 63 on the west side of the pueblo, and in the fill of Rooms 80-81 on the east side. Centrally-located Room 48 contained two macaws, one of which was nearly complete when it was recovered in the fill of the room. Single macaws were recovered from inside Rooms 62 and 67, and just outside of Room 68 in a trash deposit. Twenty-three of 48 total macaws and parrots from Wupatki have no recorded contextual information or lost contextual information during screening of materials.

[2] Richard Van Valkenburgh incorrectly states that five parrot burials were found in Room 43 (Colton et al. 1933:80). I believe he is mistakenly referencing Room 35.

Macaw and parrot skeletons that were recovered as complete or nearly complete typically came from layers of fill above surface or trash fill in room contexts at Wupatki. Between four and eight macaws and parrots were recovered inches above the floor in the fill of Room 35 (Colton et al. 1933:6). One of the birds had been disturbed by rodents, which may have led later researchers to mis-identify scattered elements as additional birds (e.g., A0.82, A0.321). These birds were all wrapped in rush matting, a treatment typically afforded to human burials at Wupatki, but also observed in the burial of two young dog skeletons found in the fill of Room 35C (Colton et al 1933:6). One of the birds (A0.542, WUPA7492/7532) was recovered from the base of the south wall of Room 35 resting against a human mandible. Given the scattered nature of the human remains, it is unlikely that the human and bird elements were associated at the time of burial, but human remains found in higher levels of the fill of Room 35 demonstrate a context in which humans returned to bury other humans alongside macaws and parrots. A similar pattern was observed in Room 80, which contained a number of subadult burials that were not directly associated with macaws recovered in Rooms 80-81, but appeared to share the same spaces in death. Room 73, the largest room associated with the bedrock spur at the center of Wupatki, also contained the hurried burial of a subadult and remains of a macaw that were not associated[3] (Richert 1952). The collection of complete or nearly complete macaws and parrot skeletons recovered at Wupatki indicate that these birds were associated with the earliest and most Chaco-like segments of the site, and may also

[3] Richert offhandedly mentions that eggshells were found underneath a Tusayan White Ware dipper associated with the burial in Room 73, though I have found no mention of eggshells elsewhere.

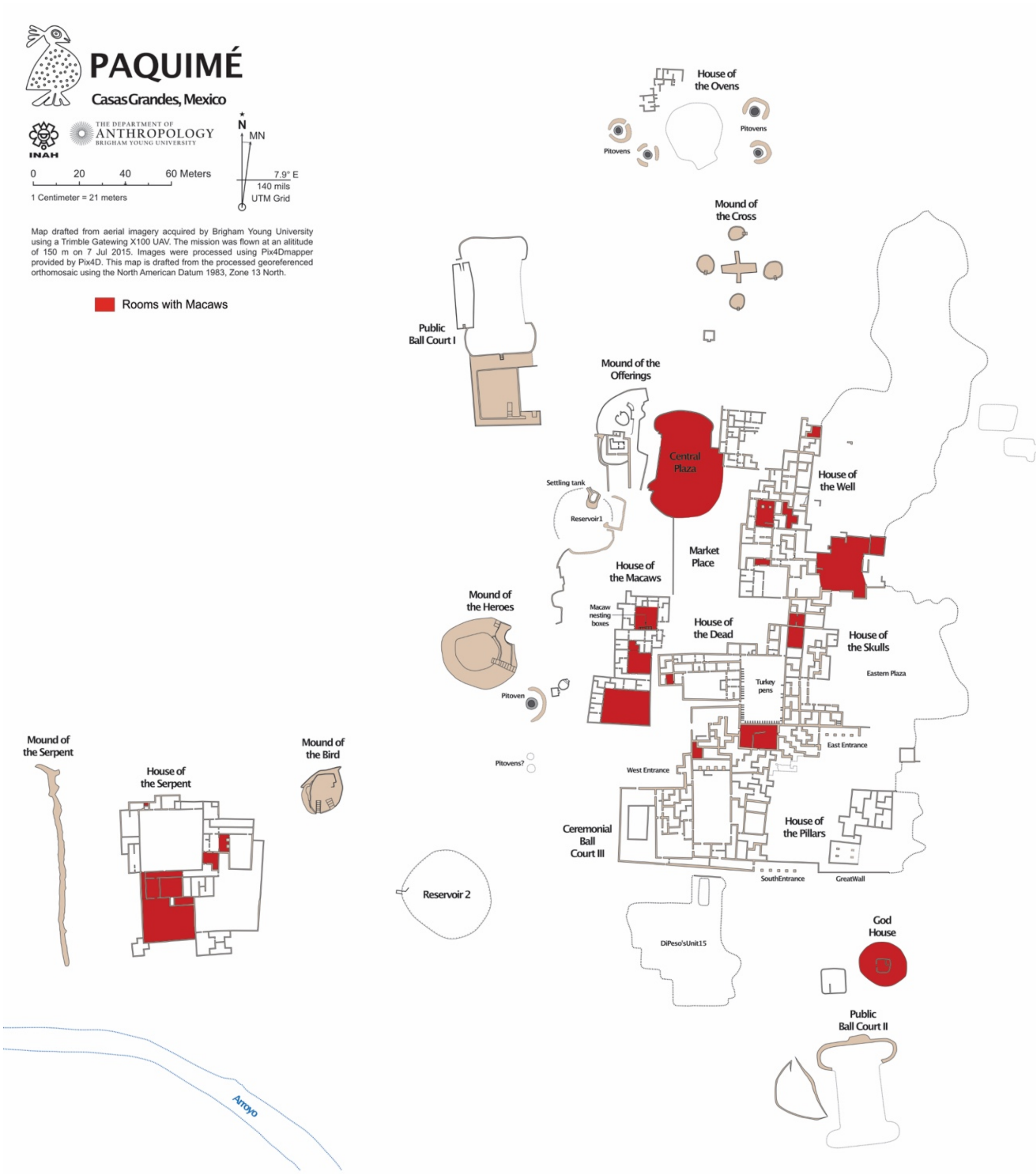


Figure 19. Locations of all macaws and thick-billed parrots recovered from Paquimé. Map adapted from Ure and Searcy (2016).

be antecedents to parrot clan visits to Wupatki amongst Hopis and Zunis as early as the 14th century (Stanislawski 1963:532-533).

Paquimé

In total, 505 macaws and parrots were recovered in excavations at Paquimé (Table 6, McKusick 1974). Scarlet macaws were most common, with 322 (64%) individual birds. There were 100 indeterminate macaws (19.9%), and 81 military macaws (15.9%). Additionally, there were two thick-billed parrots. The collection of macaws from Paquimé represents the largest population yet discovered at an archaeological site. McKusick (1974:280-281) identified pathologies on 234 scarlet macaw bones at Paquimé (compared to just 43 instances in 344 turkeys), and she suggests that these pathologies were likely a mix of human aggression toward scarlet macaws, macaw aggression toward other macaws, and the result of poor diet and/or lack of sunlight (Chapter 2). To my knowledge, no systematic study has been done on human cut-marking, weathering, rodent gnawing, or root etching in Paquimé's scarlet macaw population. Humans did modify macaw bones (n = 9, 23.1% of all bird bone tools from Paquimé), primarily to create highly polished beads.

Given the massive quantities of macaws recovered from Paquimé, I cannot cover the contextual details of every bird here, but I can highlight some of the patterns in spatial patterning and deposition that characterize human-macaw interactions at Paquimé (Figure 19). Rakita and Cruz (2015) report that a majority of scarlet macaws at Paquimé were recovered in three compounds: 54% in Unit 12 (House of the Macaws), 28.3% in Unit 11 (House of the Serpent), and 11.8% in Unit 8 (House of the Well). Macaws were not restricted to these compounds, as six or fewer macaws were also recovered from each of

Units 6, 15, 16, 18, and 21 (Rakita and Cruz 2015). The presence of macaw nesting boxes and cage stones in contexts throughout Paquimé also indicates that while these three compounds may have been central loci of macaw aviculture, they did not have exclusive access to macaws (Minnis 1988). Macaw remains were primarily recovered scattered within plaza contexts, with Plazas 3-12 (n = 242, 48.1%), 3-11 (n = 72, 14.3%), 5-12 (n = 25, 5.7%) and 6-12 (n = 22, 4.4%) having the most numerous quantities of macaws. Macaws were also common in room contexts, especially in Rooms 19-8 (n = 44, 8.7%) and 38-11 (n = 28, 5.6%). There does not appear to be any locational preference for scarlet over military macaws (or vice versa); both are found distributed throughout Paquimé. According to McKusick (1974), most of the macaws deposited at Paquimé were intentionally buried, either individually or with other birds, including macaws, thick-billed parrots, common turkeys (*Melleagris gallopavo*), and common ravens (*Corvus corax*). Scarlet macaws were recovered in contexts associated with only human remains, military macaws and human remains, and turkeys and human remains. Scarlet and military macaws were discovered headless in single and multiple burials, in circular arrangements incorporating scarlet and military macaws possibly to indicate color directional symbolism (Holeman 2013, 2015), and in circular arrangements incorporating scarlet and military macaws where only some macaws were headless (McKusick 1974). Though patterns in macaw deposition are not mirrored elsewhere in the SW/NW, they are not completely unique. Turkeys were given similar treatments (e.g., evidence of local rearing and breeding; burials with humans, macaws, and other birds; headless burials) across the settlement.

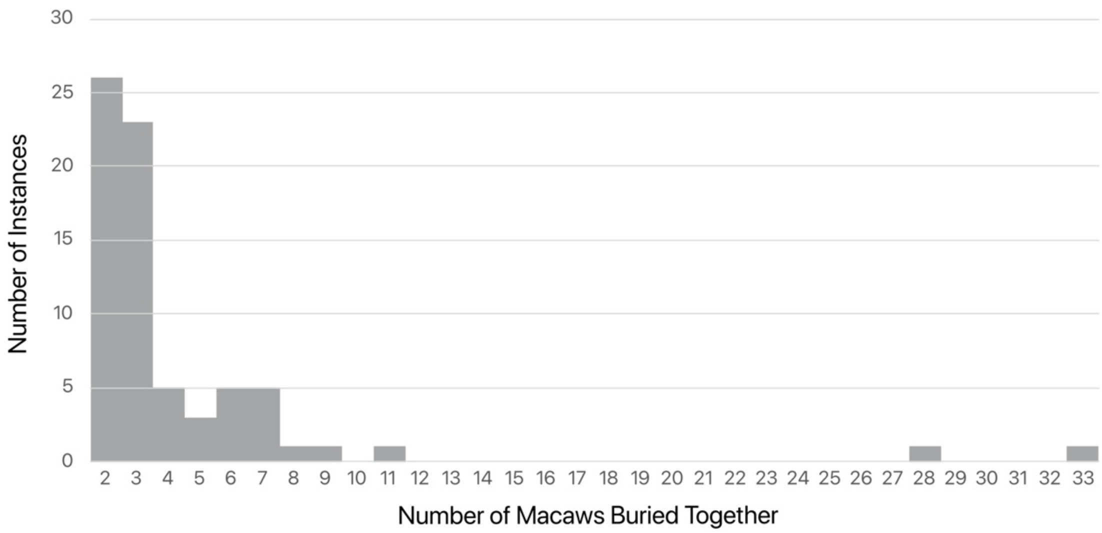


Figure 20. Histogram of instances of multiple macaw burials at Paquimé.

Macaws would have been pervasive in daily life at Paquimé. Even if only a handful were present at any given time, they could have been seen and heard throughout the site (Chapter 2). Their pervasiveness indicates that knowledge of macaw keeping and perhaps breeding was shared by various family units and not restricted, though the intensity of macaw aviculture varied across Paquimé (Rakita and Cruz 2015). The deposition of military macaws in burials at Paquimé may have been an intentional choice based on their green coloration. McKusick (1974) notes that of the 60 burials in which multiple macaws were deposited together, 39 contained mixed color burials—115 scarlet macaws and 59 military macaws, which is 72.8% of the total count of military macaws recovered from Paquimé. Multiple macaw burials vary in number from two to 33, with the vast majority of multiple interments occurring deposited in pairs (n = 25) or groups of three macaws (n = 23) (Figure 20). The intentional burial of macaws with humans, other macaws, and other birds, suggests that their multi-faceted significance extended into the afterlife.

Genealogy: Patterns of Acquisition, Treatment, and Deposition through Time

Comparing all three case studies reveals variability in patterns of scarlet macaw acquisition over time in the SW/NW. Paquimé has typically been seen as the most likely settlement to have locally raised scarlet macaws in the SW/NW, but most of the macaws sampled in this study appear to have been locally raised, indicating that most or all of their lives were spent in the SW/NW. Findings from radiogenic strontium isotope analysis presented here demonstrate that all sampled macaws were locally raised at Pueblo Bonito and Wupatki between 900 and 1220 CE. This is consistent with evidence of macaw keeping features such as the "aviary" in Room 38 at Pueblo Bonito. However, this runs contrary to arguments for the importation of macaws to Wupatki (Wilcox 2002), where there is no evidence for macaw aviculture aside from the presence of the birds themselves and the possible presence of eggshell noted above. The finding that macaws were being locally raised at Pueblo Bonito and Wupatki suggests that people inhabiting both settlements were probably familiar with or even living alongside scarlet macaws for periods of time, though who exactly was able to interact with the macaws may have been restricted (more below). Paquimé (1150/1200-1450 CE) demonstrates a much more variable pattern of macaw acquisition that suggests that the birds were both raised at the site, acquired from local settlements, and also acquired from extra-regional settlements (Chapter 3). This mixed strategy that incorporates local raising and acquisition from various sources may have been adopted to meet demand that exceeded the local supply of scarlet macaws at the settlement.

Differences in patterns of deposition of scarlet macaws across time and space reveal considerable variability in placemaking strategies in the SW/NW. The restriction of Pueblo Bonito's scarlet macaw population to the northern arc of the settlement and lack of surface modifications on scarlet macaw remains indicates restrictive access to and careful control over deposition of the birds (Bishop 2019; Bishop and Fladd 2018; Plog et al. 2021). Bishop and Fladd's (2018) observation that macaws were consistently deposited in subfloor contexts probably as a result of their association with construction, occupation, or closure of living spaces is both important and apparently unique to Pueblo Bonito. Interaction with live birds—even if restricted—appears to have been the norm given that a majority (n = 17) of Pueblo Bonito's macaws were killed in roof fall events. Wupatki's macaw population was more fragmentary than those in the other case studies. For the birds whose depositional histories could be reconstructed, macaws and parrots were commonly deposited in the fill above floors in room contexts and given treatments similar to those observed in humans (e.g., common burial spaces, wrapped in rush matting). All (n = 21-25) macaws with clear contextual information were recovered from the southern roomblock; many came from a segment of rooms that exhibits the most "Chaco-like" features (i.e., Chaco-style masonry and T-shaped doorways, presence of possible kivas, presence of rare, non-local material culture observed at Pueblo Bonito and Chaco Canyon more generally). The burial of macaws and humans in the same spaces is another similarity with a pattern observed once at Pueblo Bonito (Room 309), though the inhabitants of Wupatki never deposited humans and macaws in direct association. While macaws tended to be deposited in construction, occupation, or closure events at Pueblo Bonito, humans and macaws tended to warrant burial in shared burial spaces at Wupatki.

Despite the fact that Wupatki and Paquimé overlap in habitation dates, respective patterns in macaw deposition appear to be unique to each settlement. Paquimé incorporates patterns seen at Pueblo Bonito and Wupatki, such as the keeping of live macaws in the settlement and burial of macaws alongside humans, but on a scale previously unknown to the SW/NW. Humans—who were likely responsible for care of macaws—were buried alongside single and multiple scarlet macaws and military macaws (Holeman 2013, 2015; McKusick 1974; Whittlesey and Reid 2013). Birds were kept in plaza spaces, and then buried directly in the plazas, but not exclusively. Given the extensive deposition of macaws in all parts of the settlement (Figure 20), it is difficult to say whether the deposition of macaws was associated with any given human behaviors (e.g., construction, closing, sacrifice, etc.). Instead, they appear to have been ever-present, involved in a range of human behaviors.

Even given differences in macaw acquisition and deposition in the SW/NW between 900 and 1450 CE, some similarities existed through time and across space. Despite a distant natural habitat and associations with the south, macaws recovered from regional centers in the SW/NW probably spent most or perhaps all of their lives in the SW/NW. The evidence presented here suggests that there may have been little or no need to travel all the way to eastern or southern Mexico to procure the birds, until the increases in macaw demand seen at Paquimé necessitated other sources of macaws. The deposition of macaws and humans in shared spaces occurs in all three cases. Though rare at Pueblo Bonito and never in direct association at Wupatki, the decision to intentionally bury macaws and humans in shared spaces speaks to similarity in how macaws fit into cosmology and worldview. Pathologies in macaw bones were also observed in all three case studies. This perhaps indicates that non-native scarlet macaws were kept in conditions that were challenging, probably due to a combination of factors including (but not limited to), arid climatic conditions, inadequate food supply and/or diversity, lack of access to sunlight, and interactions amongst the macaws or interactions amongst macaws and humans. This final point is especially salient given findings from Chapter 2 and hints that the aggressive temperament of scarlet macaws extends into human-macaw interactions in the past.

Conclusion

In this chapter, I have used isotope biogeochemistry and detailed contextual analyses in a Material Histories theoretical framework to investigate the acquisition, treatment, and deposition of scarlet macaws in the process of placemaking at three regional centers in the SW/NW. I found variation in how people used scarlet macaws in placemaking at different times and places between 900 and 1450 CE. Radiogenic strontium isotope analysis of scarlet macaw bone tissue from Pueblo Bonito, Wupatki, and Paquimé indicates that humans primarily raised macaws locally instead of procuring them from their distant endemic homeland in southern and eastern Mexico. At Paquimé, macaws were also procured from both the surrounding Casas Grandes region and extra-regionally, perhaps to meet increasing demands for macaws and their feathers. Contextual analyses suggest that macaws and parrots were treated and deposited in prescribed ways that varied over time and across space. Macaws at Pueblo Bonito were restricted to the northern arc of the great house, kept live, and intentionally interred as part of construction and perhaps also closing rites (Bishop 2019; Bishop and Fladd 2018;

Plog et al. 2021). Few intentional burials of macaws were recovered from Wupatki, but those that were interred were placed in post-habitation room fill with other ritual and trash deposits, and given similar treatments to humans. Macaws and parrots from Wupatki were never found in direct association with humans, but they were deposited in similar spaces. Most of Wupatki's intentionally buried macaws come from the Chaco-like segment of the southern roomblock and immediately surrounding spaces, which indicates that the deposition of macaws and parrots may echo cosmological principles observed at Chaco Canyon, but in a distinctly local way. The quantity and treatment of macaws at Paquimé are almost unique to the SW/NW (see Whittlesey and Reid [2013] for a discussion of similarities between macaw deposition at Paquimé and Grasshopper). Scarlet macaws were deposited throughout Paquimé, scattered across plazas and rooms, in individual burials, and in direct association with humans, other macaws (i.e., military macaws), and turkeys. The pervasive deposition of scarlet macaws indicates that various groups of people living at Paquimé had access to local and non-local scarlet macaws. Macaws at Paquimé were likely essential components of daily life as they were seen and heard by all groups of people living at the site. This significance likely extended into the cosmological realm as macaws and humans were interwoven materially into the afterlife.

Findings from this study add to a growing body of literature refining the patterns of interaction and exchange between Mesoamerica and the SW/NW (e.g., Crown and Hurst 2009; George et al. 2018; Thibodeau et al. 2018). Despite the distant, non-local origin of scarlet macaws, most of those sampled from the regional centers of Pueblo Bonito, Wupatki, and Paquimé were raised locally, spending most of their lives at SW/NW settlements. If these birds were transported from distant locations—as is described in the ethnohistoric literature (Nelson et al. 2021)—this likely occurred when the birds were quite young. This is consistent with findings from examining the human experience of transporting scarlet macaws over long distances (Chapter 2).

Though scarlet macaws occur at settlements throughout the SW/NW, the appearance of scarlet macaws does not indicate a uniform cosmology or shared prescriptions regarding the treatment and deposition of these birds. Between 900 and 1450 CE, macaws and parrots appear to have been incorporated into human lives (and deaths) in various ways, indicating differences in beliefs about how these animals were incorporated into local worldviews. Such a pattern is consistent with widespread variation in belief systems manifested in ritual treatment of animals in the pre-Hispanic SW/NW (McGuire 2011; Schwartz 2018). This pattern continues to be observed today in variations in belief and use of macaws and parrots amongst ancestral peoples living in the SW/NW (Whiteley 2021).

The research presented here opens a number of avenues for future consideration. The detailed contextual zooarchaeological work on macaw remains from Pueblo Bonito completed by Bishop and Fladd (2019), Bishop (2019), and Plog et al. (2021) and begun here for Wupatki has great potential to answer and create new questions. Despite the incredible interest garnered by the many scarlet macaws recovered at Paquimé, contemporary zooarchaeological analysis is still lacking. A study of the treatment and deposition of scarlet macaws at Paquimé could make major contributions to our understanding of Paquimé’s cosmology and influence in larger SW/NW exchange networks post-1250 CE.

Ancient DNA research on scarlet macaw remains, such as that done by George et al. (2018) has great potential to assess the relatedness of scarlet macaw populations recovered at archaeological sites in the SW/NW and thus the exchange or social networks that served to distribute macaws throughout region. The analysis of mitochondrial DNA in Wupatki and Paquimé macaws could answer the question of whether the inhabitants of these settlements procured macaws from the same source (or sources) as people at Chaco and Mimbres. The pairing of aDNA and radiogenic strontium isotope analysis has the potential to assess another question with far-reaching implications: Did Paquimé supply the rest of the SW/NW with macaws between 1200 and 1450 CE, or was Paquimé the final resting place of scarlet macaws raised at the site, as some (Bradley 1996; Vargas 1995; Whalen 2013) have suggested.

This research only explores part of the story of macaw acquisition and deposition in the SW/NW between 900 and 1450 CE. During this time macaws occurred at other regional centers—and all types of settlements—throughout the SW/NW. Detailed contextual analyses and use of isotopic analyses and ancient DNA in macaw remains recovered from these settlements will be necessary before a more complete picture can be drawn.

Chapter 5:

CONCLUSION

In Chapter 1, I discussed the significance of scarlet macaws in traditional histories and clan migrations amongst Hopi, Zuni, and other descendant communities living in the SW/NW. The traditional Zuni story of the origins of the Macaw-people and the Raven-people recounts the selection of macaw eggs that split these groups and began a journey of Macaw-people south to Mexico (Whiteley 2021). Hopi traditional stories (e.g., the story of Tiyo) and clan migrations also tell of groups of people either traveling south and returning later or beginning in the south and traveling north to meet in lands understood to be present-day Arizona. These stories and histories are relational in nature, meaning that concepts like values and ideologies that are separated in Western thought are interconnected with elements of place and processes of placemaking (Hopkins 2012). Wupatki sits at the center of many of these stories as a central meeting place (Hopkins 2012) and a Hopi legend noted by Stanislawski (1963:61-62) suggested that Wupatki was the last home of the parrot clan. Greiser (1995:506) recounts stories of southward travel associating scarlet macaws with the adoption of Meosamerican agricultural technologies (e.g., irrigation systems) amongst Hopi, Zuni, and Taos communities. In this context, the presence of scarlet macaws at pre-Hispanic regional centers in the SW/NW is unsurprising. It is perhaps the remarkable time depth of exposure to and interactions with scarlet macaws that led to their incorporation into traditional histories and Puebloan cosmology. Even though scarlet macaws sampled in this study were predominantly raised in the SW/NW, individuals or groups of people would have had to procure a successful breeding pair of scarlet macaws before they could be bred locally. The routes people traveled would have been known to ancestral communities and could have been passed on through stories or even songs (Darling 2006; Darling and Lewis 2007). These journeys are tied up in long-distance travel, clan migrations, and traditional histories of descendant communities in the SW/NW today.

The time depth of scarlet macaw significance to people of the SW/NW—from at least 900 until today—is one line of evidence among many that macaws and parrots were important elements in the making of place. With that as the only line of evidence, it might be easy to assert that scarlet macaws were just a fancy object that fascinated people. The research presented in this dissertation provides many lines of evidence to the contrary. If space is made and re-made through reiterative social practice on a daily basis (Cresswell 2004), then this research demonstrates the ways in which the acquisition, treatment, and deposition are woven into placemaking through the performance of daily life.

In exploring the acquisition of scarlet macaws at regional centers in the SW/NW, I found that macaws were primarily locally raised at Pueblo Bonito, Wupatki, and Paquimé. Resources, including food, water, and dedicated space were marshalled for their care in all three settlements and at least some people knew how to care for the birds. At Pueblo Bonito, access to the live macaws and perhaps also knowledge of their care were restricted to specific people or groups of people (Bishop 2019; Bishop and Fladd 2018; McKusick 1974; Plog et al. 2021). I am not the first to find evidence for the local raising of macaws in the Casas Grandes region in Chihuahua: Identification of macaw cage stones outside of Paquimé at local Casas Grandes settlements led Minnis et al.

(1993) to suggest that the raising of macaws was a pan-regional phenomenon. Results from radiogenic strontium isotope analysis presented here support that interpretation and provide potential locales (including Ch-159, Ch-254, and Cerro Juanaqueña) in which macaws may have been raised. One of these potential macaw-raising locales might actually be an extra-regional settlement, 76 Draw, located in the Mimbres region. Between 900 and 1450 CE, people locally raised birds, but the variation in that pattern later in time may be a result of Paquimé's nature as a ceremonial center to which rare objects and materials were imported in massive quantities (Bradley 1996; Vargras 1995; Whalen 2013).

In exploring the deposition of macaws, I found there to be variation in their treatment. At Pueblo Bonito and Paquimé, people constructed facilities where they could care for live birds, indicating their significance to the local social order. These areas were restricted at Pueblo Bonito but at Paquimé, macaws and their care were common knowledge, or at least accessible to most parts of the settlement (Bishop 2019; Bishop and Fladd 2018; Di Peso 1974; Di Peso et al. 1974). Human-like burial treatments and the scattered nature of the Wupatki macaw population demonstrate differences in treatment, but the deposition of most complete or nearly complete macaw skeletons in the central, Chaco-like core of the southern roomblock echoed placemaking strategies observed first at Pueblo Bonito. The above patterns in deposition of macaws strengthen understandings of Wupatki's connection to the larger Chacoan regional system (O'Hara 2015; Stanislawski 1963; Wilcox 2002).

Exploration of the human experiences associated with macaws clarifies the extent of knowledge and behaviors required for their care, and how this is wrapped up in placemaking. Knowledge of their care was probably specialized at Pueblo Bonito and Wupatki, but may have been known to the general population by the time of Paquimé. This knowledge would have bestowed prestige or political authority on those who had access to it—being a person or a group of people who could make macaws speak, fly, attack, or do specific behaviors was esoteric and linked to powerful far-away places (Helms 1991, 1993), even if the birds themselves were more readily accessible. Learning to keep macaws, or even breed them, would have ensured continued access to a multi-faceted and powerful, animate object. The Archaeology of the Human Experience approach also demonstrates the ways that the presence of macaws would have set settlements apart from their counterparts. The vibrant colors, loud sounds, and overall experience of visiting a site like Paquimé with many scarlet macaws would have been fundamentally different from visiting settlements without macaws. The presence of macaws could have brought power and standing to groups of people caring for them, but it could also have brought zoonotic infectious diseases like psittacosis that could have substantially harmed and even killed entire populations of humans and birds. Overall, the acquisition and deposition of macaws at SW/NW regional centers contributed to a newly defined understanding of place and experience of the pre-Hispanic world between 900 and 1450 CE.

Future Directions

This research opened the doors to various directions of future study. Despite the centrality of contemporary Hopi perspectives—on the significance of macaws and parrots and macaw/parrot clans in clan migrations, traditional histories, and placemaking—to resolving the research questions in this dissertation, this element of the project fell outside what was possible in this study. An investigation into contemporary conceptualizations of macaws and parrots and macaw/parrot clans will be pursued at the completion of this project, as was requested by the Hopi Cultural Preservation Office (HCPO) at the time permissions were granted for this project.

Incorporating analyses of full genome and mitochrondrial DNA alongside radiogenic strontium isotope analysis in scarlet macaws from Wupatki and elsewhere in the SW/NW is another area of great interest to Hopi consultants who lent their time to this study. The study by George et al. (2018) of macaw mitochondrial DNA from sites in the Chaco and Mimbres regions demonstrated that these methods have great potential to detail the networks that served to distribute macaws throughout the region. Illuminating these networks and the life histories of macaws through radiogenic strontium isotope analysis, as was done in this study, will also speak to clan histories, migrations, and the affiliations between ancestral sites and macaws and parrots. For instance, the combination of these analyses could further address Wupatki's significance as an ancestral meeting place of the macaw/parrot clan. Additionally, the analysis of mitochondrial DNA in Wupatki and Paquimé macaws alone could provide comparative case studies for assessing the question of whether the inhabitants of these settlements procured macaws from the same source, or sources, as people in the Chaco Canyon and Mimbres regions. Pairing ancient DNA with radiogenic strontium isotope analysis has the potential to assess another question with far-reaching implications: Did Paquimé supply the rest of the SW/NW with macaws between 1200 and 1450 CE, or was Paquimé the final resting place of scarlet macaws raised at the site, as some have suggested for other objects and materials found there (Bradley 1996; Vargas 1995; Whalen 2013). Topics like this—where the interests of descendant communities and archaeological researchers align—can and should be of central interest to archaeology moving forward.

While this dissertation has demonstrated that scarlet macaws were important in the past, their full significance cannot be made fully clear until patterns of deposition are assessed for other rare, non-local, and utilitarian objects and materials recovered in all three case studies. Though instances of object co-associations and bundling were not discovered in the present study, the possibility remains that macaws were acquired and deposited in very similar patterns to other rare (e.g., shell objects, stone palettes, turquoise and blue-green stones), non-local (e.g., copper bells, shell trumpets), or even utilitarian (e.g., plainware ceramics, stone tools) objects and materials. Until these object and material types are given full consideration in all three case studies—and elsewhere in the SW/NW—it remains possible that macaws could have been treated like other objects and materials.

This study has characterized scarlet macaws in process of placemaking at Pueblo Bonito, Wupatki, and Paquimé. However, this is just a small sample of settlements containing scarlet macaw remains and it remains to be seen whether changes in these processes are mirrored elsewhere in the SW/NW. A forthcoming volume (Schwartz et al. 2021) will add to this picture by describing the role of scarlet macaws for Mimbres (e.g., Galaz, Cameron Creek), Western Pueblos (i.e., Point of Pines, Grasshopper, Turkey Creek Pueblo, Kinishba), Hohokam (e.g., Snaketown, Gatlin Site, Las Colinas, Las Fosas), northern Sinagua (e.g., Nalakihu, Ridge Ruin), and other Chaco Canyon settlements (e.g., Pueblo del Arroyo, Kin Kletso). This will contribute to a greater understanding of pan-SW/NW patterns in traditional culture areas, but will still lack data from other important areas, including (but not limited to) the Mesa Verde, Rio Grande, Prescott Valley, and southern Sinagua regions. Given the uneven distribution of scarlet macaw remains, which typically favors larger settlements and regional centers, smaller settlements with fewer instances of scarlet macaw remains have traditionally been understudied. To better understand regional patterns of macaw acquisition and deposition, smaller sites will also need to be incorporated into these studies.

Finally, the detailed zooarchaeological and contextual analyses conducted on scarlet macaws from Chaco Canyon completed by Bishop (2019) and Plog et al. (2021) and begun here for Wupatki has great potential to both answer and create new questions. Paquimé stands alone in the SW/NW for its massive collection of scarlet macaws, but detailed zooarchaeological analyses are still lacking for the macaw population. More detailed study of pathology and deposition through re-analysis of skeletal materials and archival records could make major contributions to our understanding of human-animal interactions and cosmology at Paquimé and help to define its influence in larger social networks of the SW/NW.

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APPENDIX A

AUTHOR CONTRIBUTIONS

Chapter 2 of this dissertation was adapted from a book chapter entitled “The Human Experience of Transporting and Raising Scarlet Macaws at Paquimé in Northwestern Chihuahua” that is currently in review and will be published in a forthcoming edited volume. This article was co-authored by the author of this dissertation, Kelley L.T. Taylor, and Michelle Hegmon. Both Taylor and Hegmon have granted their permission to for a modified version of this article to be incorporated into this dissertation.

APPENDIX B

CONTEXTUAL AND DEPOSITIONAL INFORMATION FROM ARCHAEOLOGICAL MACAW AND PARROT SPECIMENS FROM PUEBLO BONITO, WUPATKI, AND PAQUIME

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
Pueblo Bonito (New Mexico, USA) [n = 37 scarlet macaws, indeterminate macaws, & thick-billed parrots]						
H/6452		Scarlet macaw	Whole	Room 71	Floor contact	
H/6451		Macaw	ND[a]	Room 71	Floor contact	
H/6708		Scarlet macaw	Whole	Room 78	Floor contact	
H/6709		Scarlet macaw	Whole	Room 78	Trash	
343573a		Scarlet macaw	Partial	Room 251	ND	
343573b		Scarlet macaw	Partial	Room 251	ND	
343577		Macaw	Partial	Room 255	Fill above floor	
343581		Scarlet macaw	Whole	Room 306	Subfloor pit	
343580		Scarlet macaw	Partial	Room 306	Subfloor pit	
343580		Scarlet macaw	Partial	Room 306	Subfloor pit	
343580		Scarlet macaw	Partial	Room 306	Subfloor pit	
FS# 1256		Thick-billed parrot	Whole	Room 308	Floor contact	
343579		Scarlet macaw	Whole	Room 309	Floor contact	Associated with infant burial
343583		Scarlet macaw	Partial	Kiva J	ND	
AT 25079		Macaw	Partial	Kiva J	ND	
343578		Scarlet macaw	Partial	Room 249A	Floor contact	
343571		Scarlet macaw	Whole	Room 249A	Floor contact	
343572		Scarlet macaw	Partial	Room 249A	Floor contact	
343576		Scarlet macaw	Whole	Room 249A	Floor contact	
FS #295		Macaw	Partial	Room 249A	Floor contact	
H/5239		Scarlet macaw	Whole	Room 38	Subfloor pit	
H/5238		Scarlet macaw	Whole	Room 38	Subfloor pit	
H/5226		Scarlet macaw	Whole	Room 38	Floor contact	
H/5227		Scarlet macaw	Whole	Room 38	Floor contact	
H/5228		Scarlet macaw	Whole	Room 38	Floor contact	
H/5229		Scarlet macaw	Whole	Room 38	Floor contact	
H/5230		Scarlet macaw	Whole	Room 38	Floor contact	
H/5231		Scarlet macaw	Whole	Room 38	Floor contact	
H/5232		Scarlet macaw	Whole	Room 38	Floor contact	
H/5233		Scarlet macaw	Whole	Room 38	Floor contact	
H/5234		Scarlet macaw	Whole	Room 38	Floor contact	
H/5235		Scarlet macaw	Whole	Room 38	Floor contact	
H/5236		Scarlet macaw	Whole	Room 38	Floor contact	
H/5237		Scarlet macaw	Whole	Room 38	Floor contact	
343575		Scarlet macaw	Partial	East Refuse Mound	Trash	

[a]ND = No Data

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
343574		Scarlet macaw	Whole	East Refuse Mound	Trash	
343584		Thick-billed parrot	Partial	East Refuse Mound	Trash	
Wupatki (Arizona, USA) [n = 48 scarlet, military, & indeterminate macaws, & thick-billed parrots]						
W105	WUPA 909	Scarlet macaw	Whole	Room 81	Fill above floor	
W50	WUPA 25666	Scarlet macaw	Whole	Room 80-81	Fill above floor	
W52/W87-W94		Thick-billed parrot	Partial	Room 80-81	Fill above floor	
W84	WUPA 25668	Scarlet macaw	Partial	Room 80-81	Fill above floor	
A0.528	WUPA 7382	Scarlet macaw	Partial	Room 73	ND	
A0.192		Thick-billed parrot	Partial: 1 element	Near Room 68	Trash	
A0.534	WUPA 7383	Scarlet macaw	Partial	Room 67	ND	
A0.537	WUPA 7379	Scarlet macaw	Whole	Room 63	ND	
A0.920/A0.536		Macaw	Partial	Room 63	ND	
A0.752	WUPA 7406	Macaw	Partial: 1 element	Room 62	ND	
A0.529	WUPA 7392	Macaw	Partial: 1 element	Room 48	ND	
A0.535	WUPA 7384	Scarlet macaw	Whole	Room 48	Fill above floor	
A0.323	WUPA 7416	Macaw	Partial: 1 element	Room 43	Trash	
A0.538	WUPA 7377	Scarlet macaw	Whole	Room 43	ND	
A0.160	WUPA 7395	Macaw	Partial: 2 elements	Room 41	ND	
A0.533	WUPA 7398	Scarlet macaw	Partial: 2 elements	Room 41	ND	
A0.755	WUPA 7417	Macaw	Partial: 1 element	Room 41	ND	
A0.540	WUPA 7388	Scarlet macaw	Whole	Room 35C	Fill above floor	
A0.541	WUPA 7492/7532	Macaw	Whole	Room 35C	Fill above floor	
A0.542	WUPA 7376	Scarlet macaw	Whole	Room 35C	Fill above floor	
A0.544	WUPA 7393	Scarlet macaw	Partial	Room 35C	Fill above floor	
A0.543	WUPA 7382	Thick-billed parrot	Whole	Room 35C	Fill above floor	
A0.548	WUPA 7405	Scarlet macaw	Partial	Room 35A-17	Fill above floor	
A0.321		Thick-billed parrot	Partial: 1 element, may be same bird as A0.543	Room 35A	Fill above floor	
A0.82		Thick-billed parrot	Partial: 1 element, may be same bird as A0.543	Room 35	Fill above floor	
A0.555	WUPA 7414	Macaw	Partial: 1 element	"General screening"	ND	
A0.556	WUPA 7415	Macaw	Partial: 1 element	"General screening"	ND	
A0.753	WUPA 7413	Macaw	Partial: 1 element	"Screening May 1959"	ND	
A0.757	WUPA 7407	Macaw	Partial	"Screening Jan. 1940"	ND	

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
A0.766		Macaw	Partial	"Screening May 1939"	ND	
A0.80	WUPA 7396	Scarlet macaw	Partial: 1 element	"Screening trash heap"	Trash	
A0.79	WUPA 7404	Macaw	Partial: 1 element	"Trash heap"	Trash	
A0.81		Scarlet macaw	Partial: 1 element	"Trash heap"	Trash	
A0.322	WUPA 7418	Macaw	Partial: 1 element	"Miscellaneous trash"	Trash	
A0.325	WUPA 7401	Scarlet macaw	Partial: 1 element	"Miscellaneous trash"	Trash	
A0.764		Scarlet macaw	Partial	"Screening May 1939"	ND	
A0.773	WUPA 7407	Scarlet macaw	Partial: 2 elements	"Screening May 1939"	ND	
A0.531	WUPA 7402/7419	Macaw	Partial	"M.177"	ND	
A0.50	WUPA 7394	Macaw	Partial: 1 element	"Trash fill, 1933"	Trash	
A0.87	WUPA 7408	Macaw	Partial: 1 element	"54.37"	ND	
A0.324	WUPA 10706	Macaw	Partial	"54.37"	ND	
A0.325		Military macaw	Partial: 1 element	ND	Trash	
A0.183	WUPA 7391	Macaw	Partial	ND	ND	
A0.285	WUPA 7400	Macaw	Partial: 1 element	ND	ND	
A0.536	WUPA 7378	Scarlet macaw	Partial	ND	ND	
A0.539	WUPA 7385	Scarlet macaw	Whole	ND	ND	
A0.547	WUPA 7389	Scarlet macaw	Partial: 2 elements	ND	ND	
A0.549	WUPA 7390	Scarlet macaw	Partial	ND	ND	
Paquimé (Chihuahua, México) [n = 505 scarlet, military, & indeterminate macaws, & thick-billed parrots]						
CG/102	CG(b)/178B	Scarlet macaw	Partial	Central Plaza, Pit 4	Subfloor pit	
CG/770	CG(b)/635A	Military macaw	Partial	Central Plaza, Pit 4	Subfloor pit	
CG/846	CG(b)/179B	Macaw	Partial	Central Plaza, Pit 5	Subfloor pit	
CG/821	CG(b)/580A	Scarlet macaw	Partial	Pit House J-6	Fill above floor	
CG/807	CG(b)/584A	Military macaw	Partial	Pit House R-6	Fill above floor	
CG/808	CG(b)/584B	Military macaw	Partial	Pit House R-6	Fill above floor	
CG/878	CG(b)/653	Macaw	Partial	Plaza 1-8; Burial 9 A-B-8	Fill above floor	Bones of BB/13 mixed in field (Di Peso et al. 1974:4:368)
CG/861	CG(b)/459A	Macaw	Partial	Plaza 3-8; Well Stairwell	Subfloor	
CG/812	CG(b)/622E	Macaw	Partial	Room 13-8	Floor contact	
CG/767	CG(b)/625B	Macaw	Whole	Room 15C-8	Fill above floor	
CG/319	CG(b)/540A	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/8	Subfloor bird-human burial	Associated with Burials 14-8 & 15-8
CG/320	CG(b)/540B	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/8	Subfloor bird-human burial	Associated with Burials 14-8 & 15-8
CG/323.1	CG(b)/540C	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/8	Subfloor bird-human burial	Associated with Burials 14-8 & 15-8

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/323.2	CG(b)/540D	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/8	Subfloor bird-human burial	Associated with Burials 14-8 & 15-8
CG/318	CG(b)/540E	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/8	Subfloor bird-human burial	Associated with Burials 14-8 & 15-8
CG/321	CG(b)/540F	Military macaw	Whole	Room (Plaza) 19-8; BB/8	Subfloor bird-human burial	Associated with Burials 14-8 & 15-8
CG/322	CG(b)/540G	Military macaw	Whole	Room (Plaza) 19-8; BB/8	Subfloor bird-human burial	Associated with Burials 14-8 & 15-8
CG/880	CG(b)/655	Scarlet macaw	Partial	Room (Plaza) 19-8	Subfloor bird-human burial	Associated with Burials 14-8 & 15-8
	CG(b)/545A	Macaw	Whole	Room (Plaza) 19-8; BB/1	Subfloor bird burial	
	CG(b)/545B	Macaw	Whole	Room (Plaza) 19-8; BB/1	Subfloor bird burial	
CG/324	CG(b)/541A	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/325	CG(b)/541B	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	Headless macaw in multiple macaw burial BB/2-7 (McKusick 1974:304)
CG/326	CG(b)/541C	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/328	CG(b)/541D	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/329	CG(b)/541E	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/330	CG(b)/541F	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/331	CG(b)/541G	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/332	CG(b)/541H	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/333	CG(b)/541I	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/334	CG(b)/541J	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/335	CG(b)/541K	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/336	CG(b)/541L	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/337	CG(b)/541M	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/339	CG(b)/542B	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/340	CG(b)/542C	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/341	CG(b)/542D	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/342	CG(b)/542E	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/343	CG(b)/542F	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/344	CG(b)/542G	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/345	CG(b)/542H	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/346	CG(b)/542I	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/347	CG(b)/542J	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/348	CG(b)/542K	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/352	CG(b)/543B	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/353	CG(b)/543C	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/350	CG(b)/543D	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/354	CG(b)/544B	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/356.1	CG(b)/544C	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/356.2	CG(b)/544D	Scarlet macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/327	CG(b)/541O	Military macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/349	CG(b)/542A	Military macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/351	CG(b)/543A	Military macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/355	CG(b)/544A	Military macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/338	CG(b)/541N	Macaw	Whole	Room (Plaza) 19-8; BB/2-7	Subfloor bird burial	
CG/297	CG(b)/406	Scarlet macaw	Whole	Room 28-8; BB/1	Subfloor bird burial	
CG/115	CG(b)/278A	Scarlet macaw	Partial	Room 28-8	Floor contact	
CG/854	CG(b)/489A	Macaw	Partial	Room 35-8	Fill above floor	Killed accidentally; multiple, disarticulated remains (McKusick 1974:300)
CG/855	CG(b)/489B	Macaw	Partial	Room 35-8	Fill above floor	Killed accidentally; multiple, disarticulated remains (McKusick 1974:300)
CG/826	CG(b)/394B	Macaw	Partial	Room 42-8	Floor contact	
CG/768	CG(b)/609B	Scarlet macaw	Partial	Room A-8	Fill above floor	
CG/769	CG(b)/609C	Macaw	Partial	Room A-8	Fill above floor	
CG/776	CG(b)/609D	Macaw	Partial	Room A-8	Fill above floor	
CG/373.1	CG(b)/600A	Scarlet macaw	Partial	Hallway 1-11	Fill above floor	
CG/373.2	CG(b)/600B	Macaw	Partial	Hallway 1-11	Fill above floor	
CG/459	CG(b)/40B	Macaw	Partial	Plaza 3-11	Fill above floor	
CG/364.1	CG(b)/549A	Scarlet macaw	Whole	Plaza 3-11; BB/1-2	Subfloor bird burial	
CG/364.2	CG(b)/549B	Scarlet macaw	Whole	Plaza 3-11; BB/1-2	Subfloor bird burial	
CG/360	CG(b)/549C	Scarlet macaw	Whole	Plaza 3-11; BB/1-2	Subfloor bird burial	
CG/361	CG(b)/549D	Scarlet macaw	Whole	Plaza 3-11; BB/1-2	Subfloor bird burial	
CG/357	CG(b)/549E	Scarlet macaw	Whole	Plaza 3-11; BB/1-2	Subfloor bird burial	
CG/358	CG(b)/549F	Scarlet macaw	Whole	Plaza 3-11; BB/1-2	Subfloor bird burial	
CG/359	CG(b)/549G	Scarlet macaw	Whole	Plaza 3-11; BB/1-2	Subfloor bird burial	
CG/362	CG(b)/549H	Scarlet macaw	Whole	Plaza 3-11; BB/1-2	Subfloor bird burial	
CG/365	CG(b)/550B	Scarlet macaw	Whole	Plaza 3-11; BB/14	Floor contact	Associated with Nesting Box 4; killed accidentally (McKusick
CG/366	CG(b)/550C	Scarlet macaw	Whole	Plaza 3-11; BB/14	Floor contact	Associated with Nesting Box 4; killed accidentally (McKusick
CG/367	CG(b)/550D	Scarlet macaw	Whole	Plaza 3-11; BB/14	Floor contact	Associated with Nesting Box 4; killed accidentally (McKusick
CG/368	CG(b)/550E	Scarlet macaw	Whole	Plaza 3-11; BB/14	Floor contact	Associated with Nesting Box 4; killed accidentally (McKusick

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/369	CG(b)/550F	Scarlet macaw	Whole	Plaza 3-11; BB/14	Floor contact	Associated with Nesting Box 4; killed accidentally (McKusick
CG/370	CG(b)/550G	Scarlet macaw	Whole	Plaza 3-11; BB/14	Floor contact	Associated with Nesting Box 4; killed accidentally (McKusick
CG/371	CG(b)/550H	Military macaw	Whole	Plaza 3-11; BB/14	Floor contact	Associated with Nesting Box 4; killed accidentally (McKusick
CG/372	CG(b)/550I	Military macaw	Whole	Plaza 3-11; BB/14	Floor contact	Associated with Nesting Box 4; killed accidentally (McKusick
CG/98	CG(b)/159D	Scarlet macaw	Whole	Plaza 3-11; BB/15	Floor contact	Associated with Nesting Box 14; killed accidentally (McKusick
CG/97	CG(b)/159E	Scarlet macaw	Whole	Plaza 3-11; BB/15	Floor contact	Associated with Nesting Box 14; killed accidentally (McKusick
CG/99	CG(b)/159F	Scarlet macaw	Whole	Plaza 3-11; BB/15	Floor contact	Associated with Nesting Box 14; killed accidentally (McKusick
CG/96	CG(b)/159A	Macaw	Whole	Plaza 3-11; BB/15	Floor contact	Associated with Nesting Box 14; killed accidentally (McKusick
CG/94	CG(b)/45A	Scarlet macaw	Whole	Plaza 3-11; BB/16	Subfloor bird burial	Headless multiple macaw burial (McKusick 1974:301)
CG/93	CG(b)/45B	Scarlet macaw	Whole	Plaza 3-11; BB/16	Subfloor bird burial	Headless multiple macaw burial (McKusick 1974:301)
CG/89	CG(b)/44A	Scarlet macaw	Whole	Plaza 3-11; BB/17	Subfloor bird burial	
CG/90	CG(b)/44B	Scarlet macaw	Whole	Plaza 3-11; BB/17	Subfloor bird burial	
CG/91	CG(b)/44C	Scarlet macaw	Whole	Plaza 3-11; BB/17	Subfloor bird burial	
CG/92	CG(b)/44D	Macaw	Whole	Plaza 3-11; BB/17	Subfloor bird burial	
CG/7	CG(b)/43	Macaw	Whole	Plaza 3-11; BB/18	Subfloor bird burial	Headless single macaw burial (McKusick 1974:301)
CG/80	CG(b)/41E	Scarlet macaw	Whole	Plaza 3-11; BB/20	Subfloor bird burial	
CG/81	CG(b)/41F	Scarlet macaw	Whole	Plaza 3-11; BB/20	Subfloor bird burial	
CG/82	CG(b)/41G	Scarlet macaw	Whole	Plaza 3-11; BB/20	Subfloor bird burial	
CG/84.1	CG(b)/41H	Scarlet macaw	Whole	Plaza 3-11; BB/20	Subfloor bird burial	
CG/84.2	CG(b)/41I	Scarlet macaw	Whole	Plaza 3-11; BB/20	Subfloor bird burial	
CG/83	CG(b)/41D	Military macaw	Whole	Plaza 3-11; BB/20	Subfloor bird burial	
CG/6	CG(b)/41J	Macaw	Whole	Plaza 3-11; BB/20	Subfloor bird burial	
CG/85	CG(b)/42H	Scarlet macaw	Whole	Plaza 3-11; BB/21	Subfloor bird burial	
CG/86	CG(b)/42E	Macaw	Whole	Plaza 3-11; BB/21	Subfloor bird burial	
CG/87	CG(b)/42F	Macaw	Whole	Plaza 3-11; BB/21	Subfloor bird burial	
CG/88	CG(b)/42G	Macaw	Whole	Plaza 3-11; BB/21	Subfloor bird burial	
CG/8	CG(b)/156B	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/391	CG(b)/156C	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/392	CG(b)/156D	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/393	CG(b)/156E	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/394	CG(b)/156F	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/395	CG(b)/156G	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/396	CG(b)/156H	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/397	CG(b)/156I	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/398	CG(b)/156J	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/399	CG(b)/156K	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/400	CG(b)/156L	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/401	CG(b)/156M	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/402	CG(b)/156N	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/403	CG(b)/156O	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/404	CG(b)/156P	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/405	CG(b)/156Q	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/406	CG(b)/156R	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/407	CG(b)/156S	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/408	CG(b)/156T	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/409	CG(b)/156U	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/410	CG(b)/156V	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/411	CG(b)/156W	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/412	CG(b)/156X	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/413	CG(b)/156Y	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/414.1	CG(b)/156Z	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/414.2	CG(b)/156AA	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/414.3	CG(b)/156BB	Scarlet macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/415	CG(b)/156A	Military macaw	Whole	Plaza 3-11; BB/3-13	Subfloor bird burial	"Bones of BB/3-13 mixed in field" (Di Peso et al. 1974:5:482)
CG/382	CG(b)/608B	Macaw	Whole	Plaza 3-11; BB/30	Subfloor bird burial	
CG/383	CG(b)/608C	Scarlet macaw	Whole	Plaza 3-11; BB/31	Subfloor bird burial	"BB/31-38 were separate burials, individual proveniences not recorded" (Di Peso et al.
CG/384	CG(b)/608D	Scarlet macaw	Whole	Plaza 3-11; BB/32	Subfloor bird burial	
CG/385	CG(b)/608E	Scarlet macaw	Whole	Plaza 3-11; BB/33	Subfloor bird burial	
CG/386	CG(b)/608F	Scarlet macaw	Whole	Plaza 3-11; BB/34	Subfloor bird burial	
CG/387	CG(b)/608G	Scarlet macaw	Whole	Plaza 3-11; BB/35	Subfloor bird burial	
CG/388	CG(b)/608H	Scarlet macaw	Whole	Plaza 3-11; BB/36	Subfloor bird burial	
CG/389	CG(b)/608I	Scarlet macaw	Whole	Plaza 3-11; BB/37	Subfloor bird burial	
CG/390	CG(b)/608J	Scarlet macaw	Whole	Plaza 3-11; BB/38	Subfloor bird burial	
CG/374	CG(b)/603D	Scarlet macaw	Partial	Room 3-11	Floor contact	
CG/378	CG(b)/603F	Scarlet macaw	Partial	Room 3-11	Floor contact	
CG/375	CG(b)/603B	Military macaw	Partial	Room 3-11	Floor contact	
CG/376	CG(b)/603C	Military macaw	Partial	Room 3-11	Floor contact	
CG/377	CG(b)/603E	Macaw	Partial	Room 3-11	Floor contact	
CG/363	CG(b)/548	Scarlet macaw	Whole	Room 13-11; BB/1	Fill above floor	Killed accidentally (McKusick 1974:298)
CG/379	CG(b)/604A	Scarlet macaw	Whole	Room 15-11	Fill above floor	
CG/380	CG(b)/604B	Macaw	Whole	Room 15-11	Fill above floor	
CG/381	CG(b)/604C	Macaw	Whole	Room 15-11	Fill above floor	
CG/809	CG(b)/606A	Scarlet macaw	Partial	Room 19-11	Floor contact	Killed accidentally, multiple, disarticulated remains (McKusick 1974:300)
CG/810	CG(b)/606B	Scarlet macaw	Partial	Room 19-11	Floor contact	Killed accidentally, multiple, disarticulated remains (McKusick 1974:300)

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/811	CG(b)/606C	Macaw	Partial	Room 19-11	Floor contact	Killed accidentally, multiple, disarticulated remains (McKusick 1974:300)
CG/46	CG(b)/23A	Scarlet macaw	Whole	Room 36-11; BB/22	Subfloor bird burial	
CG/49	CG(b)/23B	Scarlet macaw	Whole	Room 36-11; BB/22	Subfloor bird burial	
CG/50	CG(b)/23E	Scarlet macaw	Whole	Room 36-11; BB/22	Subfloor bird burial	
CG/47	CG(b)/23C	Macaw	Whole	Room 36-11; BB/22	Subfloor bird burial	
CG/48	CG(b)/23D	Macaw	Whole	Room 36-11; BB/22	Subfloor bird burial	
CG/61	CG(b)/27	Scarlet macaw	Whole	Room 36-11; BB/23	Subfloor bird burial	
CG/765	CG(b)/19B	Scarlet macaw	Partial	Room 37-11	Floor contact	Killed accidentally, multiple, disarticulated remains (McKusick 1974:299)
CG/764	CG(b)/19A	Military macaw	Partial	Room 37-11	Floor contact	Killed accidentally, multiple, disarticulated remains (McKusick 1974:299)
CG/33	CG(b)/20A	Scarlet macaw	Partial	Room 38-11; BB/24	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/34	CG(b)/20B	Scarlet macaw	Partial	Room 38-11; BB/24	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/35	CG(b)/20C	Scarlet macaw	Partial	Room 38-11; BB/24	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/36	CG(b)/20D	Macaw	Partial	Room 38-11; BB/24	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/39	CG(b)/21A	Scarlet macaw	Partial	Room 38-11; BB/25	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/37	CG(b)/21B	Scarlet macaw	Partial	Room 38-11; BB/25	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/38	CG(b)/21C	Scarlet macaw	Partial	Room 38-11; BB/25	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/41	CG(b)/22A	Scarlet macaw	Whole	Room 38-11; BB/26	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/40	CG(b)/22B	Macaw	Whole	Room 38-11; BB/26	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/42	CG(b)/22C	Macaw	Whole	Room 38-11; BB/26	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/43	CG(b)/22D	Macaw	Whole	Room 38-11; BB/26	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/44	CG(b)/22E	Macaw	Whole	Room 38-11; BB/26	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/45	CG(b)/22F	Macaw	Whole	Room 38-11; BB/26	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/53	CG(b)/25A	Scarlet macaw	Partial	Room 38-11; BB/27	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/54	CG(b)/25B	Scarlet macaw	Partial	Room 38-11; BB/27	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/55	CG(b)/25D	Scarlet macaw	Partial	Room 38-11; BB/27	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/1	CG(b)/25C	Macaw	Partial	Room 38-11; BB/27	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/56	CG(b)/25E	Macaw	Partial	Room 38-11; BB/27	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/57	CG(b)/25F	Macaw	Partial	Room 38-11; BB/27	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/58	CG(b)/25G	Macaw	Partial	Room 38-11; BB/27	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/51	CG(b)/24A	Scarlet macaw	Whole	Room 38-11; BB/28	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/52	CG(b)/24B	Scarlet macaw	Whole	Room 38-11; BB/28	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/59	CG(b)/26B	Scarlet macaw	Whole	Room 38-11; BB/29	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/60.1	CG(b)/26C	Scarlet macaw	Whole	Room 38-11; BB/29	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/60.2	CG(b)/26D	Scarlet macaw	Whole	Room 38-11; BB/29	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/60.3	CG(b)/26E	Scarlet macaw	Whole	Room 38-11; BB/29	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/2	CG(b)/26A	Macaw	Whole	Room 38-11; BB/29	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/60.4	CG(b)/26F	Macaw	Whole	Room 38-11; BB/29	Floor contact	Macaws killed accidentally when roof of Room 38-11 collapsed (Di Peso et al. 1974:5:509)
CG/107	CG(b)/209	Scarlet macaw	Whole	Plaza 3-12; BB/1	Subfloor bird burial	"May have originally been under nesting box floor" (Di Peso et al. 1974:5:531)
CG/109	CG(b)/211B	Scarlet macaw	Whole	Plaza 3-12; BB/2	Subfloor bird burial	"May have originally been under nesting box floor" (Di Peso et al. 1974:5:531)
CG/108	CG(b)/211A	Macaw	Whole	Plaza 3-12; BB/2	Subfloor bird burial	"May have originally been under nesting box floor" (Di Peso et al. 1974:5:531)
CG/9	CG(b)/175A	Scarlet macaw	Whole	Plaza 3-12; BB/3	Subfloor bird burial	
CG/10	CG(b)/175B	Scarlet macaw	Whole	Plaza 3-12; BB/3	Subfloor bird burial	
CG/111	CG(b)/220	Scarlet macaw	Whole	Plaza 3-12; BB/4	Subfloor bird burial	"May have originally been under nesting box floor" (Di Peso et al. 1974:5:531)
CG/112	CG(b)/221A	Scarlet macaw	Whole	Plaza 3-12; BB/5	Subfloor bird burial	
CG/113	CG(b)/221B	Scarlet macaw	Whole	Plaza 3-12; BB/5	Subfloor bird burial	
CG/110	CG(b)/212A	Scarlet macaw	Whole	Plaza 3-12; BB/6	Subfloor bird burial	"May have originally been under nesting box floor" (Di Peso et al. 1974:5:531)
CG/124	CG(b)/283A	Scarlet macaw	Whole	Plaza 3-12; BB/7	Subfloor bird burial	
CG/123	CG(b)/283B	Scarlet macaw	Whole	Plaza 3-12; BB/7	Subfloor bird burial	
CG/125	CG(b)/284A	Scarlet macaw	Whole	Plaza 3-12; BB/8	Subfloor bird burial	
CG/126	CG(b)/284B	Scarlet macaw	Whole	Plaza 3-12; BB/8	Subfloor bird burial	

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/127	CG(b)/284C	Military macaw	Whole	Plaza 3-12; BB/8	Subfloor bird burial	
CG/116.1	CG(b)/279A	Scarlet macaw	Whole	Plaza 3-12; BB/9	Subfloor bird burial	
CG/116.2	CG(b)/279B	Military macaw	Whole	Plaza 3-12; BB/9	Subfloor bird burial	
CG/134	CG(b)/289C	Scarlet macaw	Whole	Plaza 3-12; BB/10	Subfloor bird burial	
CG/133.1	CG(b)/289A	Military macaw	Whole	Plaza 3-12; BB/10	Subfloor bird burial	
CG/133.2	CG(b)/289B	Military macaw	Whole	Plaza 3-12; BB/10	Subfloor bird burial	
CG/135	CG(b)/290A	Military macaw	Whole	Plaza 3-12; BB/11	Subfloor bird burial	
CG/136	CG(b)/290B	Macaw	Whole	Plaza 3-12; BB/11	Subfloor bird burial	
CG/131	CG(b)/287A	Scarlet macaw	Whole	Plaza 3-12; BB/12	Subfloor bird burial	Associated with Nesting Box 6, S wall (Di Peso et al. 1974:5:531, 534)
CG/132	CG(b)/287B	Scarlet macaw	Whole	Plaza 3-12; BB/12	Subfloor bird burial	Associated with Nesting Box 6, S wall (Di Peso et al. 1974:5:531, 534)
CG/128	CG(b)/285A	Scarlet macaw	Whole	Plaza 3-12; BB/13	Subfloor bird burial	Associated with Nesting Box 6, S wall (Di Peso et al. 1974:5:531, 534)
CG/129	CG(b)/285B	Scarlet macaw	Whole	Plaza 3-12; BB/13	Subfloor bird burial	Associated with Nesting Box 6, S wall (Di Peso et al. 1974:5:531, 534)
CG/130	CG(b)/285C	Scarlet macaw	Whole	Plaza 3-12; BB/13	Subfloor bird burial	Associated with Nesting Box 6, S wall (Di Peso et al. 1974:5:531, 534)
CG/117	CG(b)/280A	Scarlet macaw	Whole	Plaza 3-12; BB/14	Subfloor bird burial	
CG/118	CG(b)/280B	Scarlet macaw	Whole	Plaza 3-12; BB/14	Subfloor bird burial	
CG/119	CG(b)/280C	Macaw	Whole	Plaza 3-12; BB/14	Subfloor bird burial	
CG/11.1	CG(b)/281A	Scarlet macaw	Whole	Plaza 3-12; BB/15	Subfloor bird burial	
CG/11.2	CG(b)/281B	Scarlet macaw	Whole	Plaza 3-12; BB/15	Subfloor bird burial	
CG/120	CG(b)/281C	Military macaw	Whole	Plaza 3-12; BB/15	Subfloor bird burial	
CG/121	CG(b)/282A	Scarlet macaw	Whole	Plaza 3-12; BB/16	Subfloor bird burial	
CG/122	CG(b)/282B	Macaw	Whole	Plaza 3-12; BB/16	Subfloor bird burial	
CG/16	CG(b)/310B	Scarlet macaw	Whole	Plaza 3-12; BB/17-19	Subfloor bird burial	
CG/17	CG(b)/310C	Scarlet macaw	Whole	Plaza 3-12; BB/17-19	Subfloor bird burial	
CG/164	CG(b)/311A	Scarlet macaw	Whole	Plaza 3-12; BB/17-19	Subfloor bird burial	
CG/15	CG(b)/310A	Military macaw	Whole	Plaza 3-12; BB/17-19	Subfloor bird burial	
CG/165	CG(b)/311B	Military macaw	Whole	Plaza 3-12; BB/17-19	Subfloor bird burial	
CG/167.2	CG(b)/311E	Military macaw	Whole	Plaza 3-12; BB/17-19	Subfloor bird burial	
CG/166	CG(b)/311C	Macaw	Whole	Plaza 3-12; BB/17-19	Subfloor bird burial	
CG/167.1	CG(b)/311D	Macaw	Whole	Plaza 3-12; BB/17-19	Subfloor bird burial	
CG/138	CG(b)/293	Scarlet macaw	Whole	Plaza 3-12; BB/20	Subfloor bird burial	
CG/139.2	CG(b)/294B	Scarlet macaw	Whole	Plaza 3-12; BB/21	Subfloor bird burial	
CG/139.1	CG(b)/294A	Military macaw	Whole	Plaza 3-12; BB/21	Subfloor bird burial	

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/141.2	CG(b)/296B	Scarlet macaw	Whole	Plaza 3-12; BB/22	Subfloor bird burial	"In pit with BB/23, 34, 41-44, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/141.1	CG(b)/296A	Military macaw	Whole	Plaza 3-12; BB/22	Subfloor bird burial	"In pit with BB/23, 34, 41-44, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/140	CG(b)/295A	Macaw	Whole	Plaza 3-12; BB/23	Subfloor bird burial	"In pit with BB/23, 34, 41-44, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/143	CG(b)/299B	Scarlet macaw	Whole	Plaza 3-12; BB/24-26	Subfloor bird burial	
CG/144	CG(b)/299C	Scarlet macaw	Whole	Plaza 3-12; BB/24-26	Subfloor bird burial	
CG/145	CG(b)/299D	Scarlet macaw	Whole	Plaza 3-12; BB/24-26	Subfloor bird burial	
CG/147.2	CG(b)/299E	Scarlet macaw	Whole	Plaza 3-12; BB/24-26	Subfloor bird burial	
CG/147.1	CG(b)/299F	Scarlet macaw	Whole	Plaza 3-12; BB/24-26	Subfloor bird burial	
CG/146	CG(b)/299A	Military macaw	Whole	Plaza 3-12; BB/24-26	Subfloor bird burial	
CG/152	CG(b)/304A	Scarlet macaw	Whole	Plaza 3-12; BB/27-31	Subfloor bird burial	
CG/153	CG(b)/304B	Scarlet macaw	Whole	Plaza 3-12; BB/27-31	Subfloor bird burial	
CG/154	CG(b)/304C	Scarlet macaw	Whole	Plaza 3-12; BB/27-31	Subfloor bird burial	
CG/155	CG(b)/305A	Scarlet macaw	Whole	Plaza 3-12; BB/27-31	Subfloor bird burial	
CG/156	CG(b)/305B	Scarlet macaw	Whole	Plaza 3-12; BB/27-31	Subfloor bird burial	
CG/158	CG(b)/305D	Scarlet macaw	Whole	Plaza 3-12; BB/27-31	Subfloor bird burial	
CG/157	CG(b)/305C	Macaw	Whole	Plaza 3-12; BB/27-31	Subfloor bird burial	
CG/137	CG(b)/291	Scarlet macaw	Whole	Plaza 3-12; BB/32	Subfloor bird burial	
CG/142	CG(b)/297	Scarlet macaw	Whole	Plaza 3-12; BB/33	Subfloor bird burial	
CG/160	CG(b)/307A	Scarlet macaw	Whole	Plaza 3-12; BB/34	Subfloor bird burial	"In pit with BB/22, 23, 41-44, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/161	CG(b)/307B	Scarlet macaw	Whole	Plaza 3-12; BB/34	Subfloor bird burial	"In pit with BB/22, 23, 41-44, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/13	CG(b)/303A	Scarlet macaw	Whole	Plaza 3-12; BB/35	Subfloor bird burial	
CG/12	CG(b)/303B	Scarlet macaw	Whole	Plaza 3-12; BB/35	Subfloor bird burial	
CG/14	CG(b)/303C	Military macaw	Whole	Plaza 3-12; BB/35	Subfloor bird burial	
CG/162	CG(b)/308	Scarlet macaw	Whole	Plaza 3-12; BB/36	Subfloor bird burial	
CG/159.1	CG(b)/306A	Scarlet macaw	Whole	Plaza 3-12; BB/37	Subfloor bird burial	
CG/159.2	CG(b)/306B	Scarlet macaw	Whole	Plaza 3-12; BB/37	Subfloor bird burial	
CG/151	CG(b)/302	Scarlet macaw	Whole	Plaza 3-12; BB/38	Subfloor bird burial	
CG/148	CG(b)/301A	Scarlet macaw	Whole	Plaza 3-12; BB/39	Subfloor bird burial	
CG/149	CG(b)/301B	Scarlet macaw	Whole	Plaza 3-12; BB/39	Subfloor bird burial	
CG/150	CG(b)/301C	Scarlet macaw	Whole	Plaza 3-12; BB/39	Subfloor bird burial	
CG/163	CG(b)/309	Scarlet macaw	Whole	Plaza 3-12; BB/40	Subfloor bird burial	
CG/234	CG(b)/345A	Scarlet macaw	Whole	Plaza 3-12; BB/41	Subfloor bird burial	"In pit with BB/22, 23, 34, 42-44, 64-69, 86" (Di Peso et al.

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/231	CG(b)/345B	Scarlet macaw	Whole	Plaza 3-12; BB/41	Subfloor bird burial	"In pit with BB/22, 23, 34, 42-44, 64-69, 86" (Di Peso et al.
CG/232	CG(b)/345C	Scarlet macaw	Whole	Plaza 3-12; BB/41	Subfloor bird burial	"In pit with BB/22, 23, 34, 42-44, 64-69, 86" (Di Peso et al.
CG/233.1	CG(b)/345D	Scarlet macaw	Whole	Plaza 3-12; BB/41	Subfloor bird burial	"In pit with BB/22, 23, 34, 42-44, 64-69, 86" (Di Peso et al.
CG/233.2	CG(b)/345E	Scarlet macaw	Whole	Plaza 3-12; BB/41	Subfloor bird burial	"In pit with BB/22, 23, 34, 42-44, 64-69, 86" (Di Peso et al.
CG/170	CG(b)/316A	Scarlet macaw	Whole	Plaza 3-12; BB/42	Subfloor bird burial	"In pit with BB/22, 23, 34, 41, 43-44, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/172	CG(b)/316B	Scarlet macaw	Whole	Plaza 3-12; BB/42	Subfloor bird burial	"In pit with BB/22, 23, 34, 41, 43-44, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/173	CG(b)/316C	Scarlet macaw	Whole	Plaza 3-12; BB/42	Subfloor bird burial	"In pit with BB/22, 23, 34, 41, 43-44, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/174	CG(b)/316D	Scarlet macaw	Whole	Plaza 3-12; BB/42	Subfloor bird burial	"In pit with BB/22, 23, 34, 41, 43-44, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/177.1	CG(b)/316E	Scarlet macaw	Whole	Plaza 3-12; BB/42	Subfloor bird burial	"In pit with BB/22, 23, 34, 41, 43-44, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/171	CG(b)/316F	Macaw	Whole	Plaza 3-12; BB/42	Subfloor bird burial	"In pit with BB/22, 23, 34, 41, 43-44, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/175	CG(b)/316G	Macaw	Whole	Plaza 3-12; BB/42	Subfloor bird burial	"In pit with BB/22, 23, 34, 41, 43-44, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/176	CG(b)/316H	Macaw	Whole	Plaza 3-12; BB/42	Subfloor bird burial	"In pit with BB/22, 23, 34, 41, 43-44, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/1772.2	CG(b)/316I	Macaw	Whole	Plaza 3-12; BB/42	Subfloor bird burial	"In pit with BB/22, 23, 34, 41, 43-44, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/230	CG(b)/344A	Scarlet macaw	Whole	Plaza 3-12; BB/43-44	Subfloor bird burial	"In pit with BB/22, 23, 34, 41,42, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/228	CG(b)/344C	Scarlet macaw	Whole	Plaza 3-12; BB/43-44	Subfloor bird burial	"In pit with BB/22, 23, 34, 41,42, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/229	CG(b)/344B	Military macaw	Whole	Plaza 3-12; BB/43-44	Subfloor bird burial	"In pit with BB/22, 23, 34, 41,42, 64-69, 86" (Di Peso et al. 1974:5:533)

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/24	CG(b)/344D	Macaw	Whole	Plaza 3-12; BB/43-44	Subfloor bird burial	"In pit with BB/22, 23, 34, 41,42, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/25	CG(b)/344E	Macaw	Whole	Plaza 3-12; BB/43-44	Subfloor bird burial	"In pit with BB/22, 23, 34, 41,42, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/26	CG(b)/344F	Macaw	Whole	Plaza 3-12; BB/43-44	Subfloor bird burial	"In pit with BB/22, 23, 34, 41,42, 64-69, 86" (Di Peso et al. 1974:5:533)
CG/220	CG(b)/337A	Scarlet macaw	Whole	Plaza 3-12; BB/45	Subfloor bird burial	
CG/221.1	CG(b)/337C	Scarlet macaw	Whole	Plaza 3-12; BB/45	Subfloor bird burial	
CG/221.2	CG(b)/337B	Military macaw	Whole	Plaza 3-12; BB/45	Subfloor bird burial	
CG/208	CG(b)/331A	Scarlet macaw	Whole	Plaza 3-12; BB/46	Subfloor bird burial	
CG/209	CG(b)/331B	Military macaw	Whole	Plaza 3-12; BB/46	Subfloor bird burial	
CG/224.1	CG(b)/340B	Scarlet macaw	Whole	Plaza 3-12; BB/47-49	Subfloor bird burial	
CG/19	CG(b)/340E	Scarlet macaw	Whole	Plaza 3-12; BB/47-49	Subfloor bird burial	
CG/22	CG(b)/340F	Scarlet macaw	Whole	Plaza 3-12; BB/47-49	Subfloor bird burial	
CG/21	CG(b)/340G	Scarlet macaw	Whole	Plaza 3-12; BB/47-49	Subfloor bird burial	
CG/224.2	CG(b)/340A	Military macaw	Whole	Plaza 3-12; BB/47-49	Subfloor bird burial	
CG/20	CG(b)/340D	Military macaw	Whole	Plaza 3-12; BB/47-49	Subfloor bird burial	
CG/437	CG(b)/340A-G	Thick-billed parrot	Whole	Plaza 3-12; BB/47-49	Subfloor bird burial	
CG/211	CG(b)/333A	Scarlet macaw	Whole	Plaza 3-12; BB/50	Subfloor bird burial	
CG/212	CG(b)/333B	Scarlet macaw	Whole	Plaza 3-12; BB/50	Subfloor bird burial	
CG/205	CG(b)/329A	Scarlet macaw	Whole	Plaza 3-12; BB/51	Subfloor bird burial	
CG/204	CG(b)/329B	Macaw	Whole	Plaza 3-12; BB/51	Subfloor bird burial	
CG/227	CG(b)/343A	Scarlet macaw	Whole	Plaza 3-12; BB/52	Subfloor bird burial	
CG/206	CG(b)/330A	Scarlet macaw	Whole	Plaza 3-12; BB/53	Subfloor bird burial	
CG/207	CG(b)/330B	Scarlet macaw	Whole	Plaza 3-12; BB/53	Subfloor bird burial	
CG/217	CG(b)/335A	Scarlet macaw	Whole	Plaza 3-12; BB/54	Subfloor bird burial	Associated with Nesting Box 5, S wall (Di Peso et al. 1974:5:531, 533)
CG/216.1	CG(b)/335B	Scarlet macaw	Whole	Plaza 3-12; BB/54	Subfloor bird burial	Associated with Nesting Box 5, S wall (Di Peso et al. 1974:5:531, 533)
CG/216.2	CG(b)/335C	Military macaw	Whole	Plaza 3-12; BB/54	Subfloor bird burial	Associated with Nesting Box 5, S wall (Di Peso et al. 1974:5:531, 533)
CG/235.2	CG(b)/346C	Scarlet macaw	Whole	Plaza 3-12; BB/55	Subfloor bird burial	
CG/235.1	CG(b)/346B	Military macaw	Whole	Plaza 3-12; BB/55	Subfloor bird burial	
CG/236	CG(b)/346A	Macaw	Whole	Plaza 3-12; BB/55	Subfloor bird burial	
CG/213	CG(b)/334A	Scarlet macaw	Whole	Plaza 3-12; BB/56,59,80	Subfloor bird burial	
CG/214	CG(b)/334B	Scarlet macaw	Whole	Plaza 3-12; BB/56,59,80	Subfloor bird burial	
CG/215	CG(b)/334C	Scarlet macaw	Whole	Plaza 3-12; BB/56,59,80	Subfloor bird burial	
CG/203	CG(b)/328	Scarlet macaw	Whole	Plaza 3-12; BB/57	Subfloor bird burial	

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/191	CG(b)/325A	Scarlet macaw	Whole	Plaza 3-12; BB/58	Subfloor bird burial	
CG/190	CG(b)/325B	Scarlet macaw	Whole	Plaza 3-12; BB/58	Subfloor bird burial	
CG/110	CG(b)/212A	Scarlet macaw	Whole	Plaza 3-12; BB/6	Subfloor bird burial	"May have originally been under nesting box floor" (Di Peso et al. 1974:5:532)
CG/222	CG(b)/338A	Macaw	Whole	Plaza 3-12; BB/60	Subfloor bird burial	
CG/223	CG(b)/338B	Macaw	Whole	Plaza 3-12; BB/60	Subfloor bird burial	
CG/219	CG(b)/336B	Scarlet macaw	Whole	Plaza 3-12; BB/61-62	Subfloor bird burial	
CG/218	CG(b)/336A	Military macaw	Whole	Plaza 3-12; BB/61-62	Subfloor bird burial	
CG/180	CG(b)/319	Scarlet macaw	Whole	Plaza 3-12; BB/63	Subfloor bird burial	
CG/192	CG(b)/326F	Scarlet macaw	Whole	Plaza 3-12; BB/64-69	Subfloor bird burial	
CG/196	CG(b)/326G	Scarlet macaw	Whole	Plaza 3-12; BB/64-69	Subfloor bird burial	
CG/193	CG(b)/326H	Scarlet macaw	Whole	Plaza 3-12; BB/64-69	Subfloor bird burial	
CG/199.1	CG(b)/326I	Scarlet macaw	Whole	Plaza 3-12; BB/64-69	Subfloor bird burial	
CG/199.2	CG(b)/326J	Scarlet macaw	Whole	Plaza 3-12; BB/64-69	Subfloor bird burial	
CG/199.3	CG(b)/326K	Scarlet macaw	Whole	Plaza 3-12; BB/64-69	Subfloor bird burial	
CG/194	CG(b)/326A	Military macaw	Whole	Plaza 3-12; BB/64-69	Subfloor bird burial	
CG/195	CG(b)/326B	Military macaw	Whole	Plaza 3-12; BB/64-69	Subfloor bird burial	
CG/197	CG(b)/326C	Military macaw	Whole	Plaza 3-12; BB/64-69	Subfloor bird burial	
CG/198	CG(b)/326D	Military macaw	Whole	Plaza 3-12; BB/64-69	Subfloor bird burial	
CG/200	CG(b)/326E	Military macaw	Whole	Plaza 3-12; BB/64-69	Subfloor bird burial	
CG/168.1	CG(b)/315B	Scarlet macaw	Whole	Plaza 3-12; BB/70-71	Subfloor bird burial	
CG/168.2	CG(b)/315C	Scarlet macaw	Whole	Plaza 3-12; BB/70-71	Subfloor bird burial	
CG/169	CG(b)/315A	Military macaw	Whole	Plaza 3-12; BB/70-71	Subfloor bird burial	
CG/202	CG(b)/327B	Scarlet macaw	Whole	Plaza 3-12; BB/72	Subfloor bird burial	
CG/251	CG(b)/362B	Scarlet macaw	Whole	Plaza 3-12; BB/72	Subfloor bird burial	
CG/250.2	CG(b)/362D	Scarlet macaw	Whole	Plaza 3-12; BB/72	Subfloor bird burial	
CG/201	CG(b)/327A	Military macaw	Whole	Plaza 3-12; BB/72	Subfloor bird burial	
CG/250.1	CG(b)/362C	Military macaw	Whole	Plaza 3-12; BB/72	Subfloor bird burial	
CG/252	CG(b)/362E	Military macaw	Whole	Plaza 3-12; BB/72	Subfloor bird burial	
CG/249	CG(b)/362A	Macaw	Whole	Plaza 3-12; BB/72	Subfloor bird burial	
CG/18.1	CG(b)/323B	Scarlet macaw	Whole	Plaza 3-12; BB/73	Subfloor bird burial	"Against Nesting Box 8" (Di Peso et al. 1974:5:533)
CG/18.2	CG(b)/323A	Macaw	Whole	Plaza 3-12; BB/73	Subfloor bird burial	"Against Nesting Box 8" (Di Peso et al. 1974:5:533)
CG/226	CG(b)/342	Military macaw	Whole	Plaza 3-12; BB/74	Subfloor bird burial	"Against Nesting Box 8" (Di Peso et al. 1974:5:533)

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/188	CG(b)/322	Military macaw	Whole	Plaza 3-12; BB/75	Subfloor bird burial	"Against Nesting Box 8" (Di Peso et al. 1974:5:533)
CG/184	CG(b)/320D	Scarlet macaw	Whole	Plaza 3-12; BB/76-77	Subfloor bird burial	"E face of Nesting Box 5" (Di Peso et al. 1974:5:533)
CG/181	CG(b)/320A	Military macaw	Whole	Plaza 3-12; BB/76-77	Subfloor bird burial	"E face of Nesting Box 5" (Di Peso et al. 1974:5:533)
CG/182	CG(b)/320B	Macaw	Whole	Plaza 3-12; BB/76-77	Subfloor bird burial	"E face of Nesting Box 5" (Di Peso et al. 1974:5:533)
CG/183	CG(b)/320C	Macaw	Whole	Plaza 3-12; BB/76-77	Subfloor bird burial	"E face of Nesting Box 5" (Di Peso et al. 1974:5:533)
CG/210	CG(b)/332	Military macaw	Whole	Plaza 3-12; BB/78	Subfloor bird burial	"E face of Nesting Box 5" (Di Peso et al. 1974:5:533)
CG/179	CG(b)/318	Scarlet macaw	Whole	Plaza 3-12; BB/79	Subfloor bird burial	
CG/237	CG(b)/349	Scarlet macaw	Whole	Plaza 3-12; BB/81	Subfloor bird burial	"Against south face of Nesting Box 4" (Di Peso et al. 1974:5:533)
CG/185	CG(b)/321A	Scarlet macaw	Whole	Plaza 3-12; BB/82-83	Subfloor bird burial	
CG/186	CG(b)/321B	Macaw	Whole	Plaza 3-12; BB/82-83	Subfloor bird burial	
CG/187	CG(b)/321C	Macaw	Whole	Plaza 3-12; BB/82-83	Subfloor bird burial	
CG/178.1	CG(b)/317A	Scarlet macaw	Whole	Plaza 3-12; BB/84	Subfloor bird burial	
CG/178.2	CG(b)/317B	Military macaw	Whole	Plaza 3-12; BB/84	Subfloor bird burial	
CG/85	CG(b)/324	Scarlet macaw	Whole	Plaza 3-12; BB/85	Subfloor bird burial	"Against E face of Nesting Box 5" (Di Peso et al. 1974:5:533)
CG/225	CG(b)/341	Military macaw	Whole	Plaza 3-12; BB/86	Subfloor bird burial	Headless single macaw burial (McKusick 1974:301)
CG/263	CG(b)/368A	Scarlet macaw	Whole	Plaza 3-12; BB/87	Subfloor bird burial	"Under front wall of Nesting Box 9" (Di Peso et al. 1974:5:533)
CG/264	CG(b)/368B	Scarlet macaw	Whole	Plaza 3-12; BB/87	Subfloor bird burial	"Under front wall of Nesting Box 9" (Di Peso et al. 1974:5:533)
CG/265	CG(b)/368C	Military macaw	Whole	Plaza 3-12; BB/87	Subfloor bird burial	"Under front wall of Nesting Box 9" (Di Peso et al. 1974:5:533)
CG/290	CG(b)/383A	Scarlet macaw	Partial	Plaza 3-12; BB/88-89	Subfloor bird burial	Associated with Nesting Box 9, S wall (Di Peso et al. 1974:5:529, 531)
CG/291	CG(b)/383B	Military macaw	Partial	Plaza 3-12; BB/88-89	Subfloor bird burial	Associated with Nesting Box 9, S wall (Di Peso et al. 1974:5:529, 531)
CG/266	CG(b)/369	Scarlet macaw	Whole	Plaza 3-12; BB/90	Subfloor bird burial	"Center of Nesting Box 9" (Di Peso et al. 1974:5:533)
CG/287.2	CG(b)/381C	Scarlet macaw	Whole	Plaza 3-12; BB/91	Subfloor bird burial	"SW corner of Nesting Box 9" (Di Peso et al. 1974:5:533)
CG/287.1	CG(b)/381B	Military macaw	Whole	Plaza 3-12; BB/91	Subfloor bird burial	"SW corner of Nesting Box 9" (Di Peso et al. 1974:5:533)

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/288	CG(b)/381A	Macaw	Whole	Plaza 3-12; BB/91	Subfloor bird burial	"SW corner of Nesting Box 9" (Di Peso et al. 1974:5:533)
CG/289	CG(b)/384	Scarlet macaw	Whole	Plaza 3-12; BB/92	Subfloor bird burial	"Nesting Box 9, partly under center of E wall" (Di Peso et al.
CG/292	CG(b)/384	Military macaw	Whole	Plaza 3-12; BB/93	Subfloor bird burial	Under floor between Nesting Boxes 8 and 9, S wall (Di Peso et al. 1974:5:531, 533)
CG/241	CG(b)/355	Macaw	Whole	Plaza 3-12; BB/94	Subfloor bird burial	"Nesting Box 8" (Di Peso et al. 1974:5:533)
CG/280	CG(b)/376	Scarlet macaw	Whole	Plaza 3-12; BB/95	Subfloor bird burial	Associated with Nesting Box 8, S wall (Di Peso et al. 1974:5:531, 533)
CG/268	CG(b)/371	Scarlet macaw	Whole	Plaza 3-12; BB/96	Subfloor bird burial	Associated with Nesting Box 8, S wall (Di Peso et al. 1974:5:531, 533)
CG/253	CG(b)/363A	Macaw	Whole	Plaza 3-12; BB/97	Subfloor bird burial	Associated with Nesting Box 7, S wall (Di Peso et al. 1974:5:531, 533); Headless single macaw burial (McKusick 1974:301)
CG/270.1	CG(b)/372C	Scarlet macaw	Whole	Plaza 3-12; BB/98-99	Subfloor bird burial	Associated with Nesting Box 7, S wall (Di Peso et al. 1974:5:531, 533)
CG/271	CG(b)/372A	Military macaw	Whole	Plaza 3-12; BB/98-99	Subfloor bird burial	Associated with Nesting Box 7, S wall (Di Peso et al. 1974:5:531, 533)
CG/269	CG(b)/372B	Military macaw	Whole	Plaza 3-12; BB/98-99	Subfloor bird burial	Associated with Nesting Box 7, S wall (Di Peso et al. 1974:5:531, 533)
CG/270.2	CG(b)/372D	Macaw	Whole	Plaza 3-12; BB/98-99	Subfloor bird burial	Associated with Nesting Box 7, S wall (Di Peso et al. 1974:5:531, 533)
CG/274	CG(b)/374C	Military macaw	Whole	Plaza 3-12; BB/100	Subfloor bird burial	Associated with Nesting Box 7, S wall (Di Peso et al. 1974:5:531, 533)
CG/275	CG(b)/374D	Military macaw	Whole	Plaza 3-12; BB/100	Subfloor bird burial	Associated with Nesting Box 7, S wall (Di Peso et al. 1974:5:531, 533)
CG/276	CG(b)/374A	Macaw	Whole	Plaza 3-12; BB/100	Subfloor bird burial	Associated with Nesting Box 7, S wall (Di Peso et al. 1974:5:531, 533)
CG/277	CG(b)/374B	Macaw	Whole	Plaza 3-12; BB/100	Subfloor bird burial	Associated with Nesting Box 7, S wall (Di Peso et al. 1974:5:531, 533)
CG/293	CG(b)/385A	Scarlet macaw	Whole	Plaza 3-12; BB/101	Subfloor bird burial	Associated with Nesting Box 7, S wall (Di Peso et al. 1974:5:531, 533)
CG/294	CG(b)/385B	Scarlet macaw	Whole	Plaza 3-12; BB/101	Subfloor bird burial	Associated with Nesting Box 7, S wall (Di Peso et al. 1974:5:531, 533)
CG/295	CG(b)/385C	Military macaw	Whole	Plaza 3-12; BB/101	Subfloor bird burial	Associated with Nesting Box 7, S wall (Di Peso et al. 1974:5:531, 533)
CG/283	CG(b)/379A	Military macaw	Whole	Plaza 3-12; BB/102	Subfloor bird burial	Associated with Nesting Box 7, S wall (Di Peso et al. 1974:5:531, 533)

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/284	CG(b)/379B	Military macaw	Whole	Plaza 3-12; BB/102	Subfloor bird burial	Associated with Nesting Box 7, S wall (Di Peso et al. 1974:5:531, 533)
CG/272	CG(b)/373A	Scarlet macaw	Whole	Plaza 3-12; BB/103	Subfloor bird burial	Associated with Nesting Box 7, S wall (Di Peso et al. 1974:5:531, 533)
CG/273	CG(b)/373B	Scarlet macaw	Whole	Plaza 3-12; BB/103	Subfloor bird burial	Associated with Nesting Box 7, S wall (Di Peso et al. 1974:5:531, 533)
CG/260	CG(b)/366A	Scarlet macaw	Whole	Plaza 3-12; BB/104	Subfloor bird burial	Associated with Nesting Box 6, S wall (Di Peso et al. 1974:5:531, 533)
CG/261	CG(b)/366B	Military macaw	Whole	Plaza 3-12; BB/104	Subfloor bird burial	Associated with Nesting Box 6, S wall (Di Peso et al. 1974:5:531, 533)
CG/281.1	CG(b)/377B	Scarlet macaw	Whole	Plaza 3-12; BB/105	Subfloor bird burial	Associated with Nesting Box 6, S wall (Di Peso et al. 1974:5:531, 534)
CG/281.2	CG(b)/377A	Military macaw	Whole	Plaza 3-12; BB/105	Subfloor bird burial	Associated with Nesting Box 6, S wall (Di Peso et al. 1974:5:531, 534)
CG/278	CG(b)/375A	Scarlet macaw	Whole	Plaza 3-12; BB/106	Subfloor bird burial	Associated with Nesting Box 6, N end (Di Peso et al. 1974:5:531, 534)
CG/279	CG(b)/375B	Scarlet macaw	Whole	Plaza 3-12; BB/106	Subfloor bird burial	Associated with Nesting Box 6, N end (Di Peso et al. 1974:5:531, 534)
CG/256.1	CG(b)/364B	Scarlet macaw	Whole	Plaza 3-12; BB/107	Subfloor bird burial	"Nesting Box 5, SW corner" (Di Peso et al. 1974:5:534)
CG/255	CG(b)/364C	Scarlet macaw	Whole	Plaza 3-12; BB/107	Subfloor bird burial	"Nesting Box 5, SW corner" (Di Peso et al. 1974:5:534)
CG/254	CG(b)/364A	Military macaw	Whole	Plaza 3-12; BB/107	Subfloor bird burial	"Nesting Box 5, SW corner" (Di Peso et al. 1974:5:534)
CG/285	CG(b)/380A	Scarlet macaw	Whole	Plaza 3-12; BB/108	Subfloor bird burial	"Nesting Box 5, S end" (Di Peso et al. 1974:5:534)
CG/286	CG(b)/380B	Macaw	Whole	Plaza 3-12; BB/108	Subfloor bird burial	"Nesting Box 5, S end" (Di Peso et al. 1974:5:534)
CG/262	CG(b)/367	Military macaw	Whole	Plaza 3-12; BB/109	Subfloor bird burial	"Nesting Box 5, partly under E wall, N end" (Di Peso et al. 1974:5:534)
CG/267	CG(b)/370	Scarlet macaw	Whole	Plaza 3-12; BB/110	Subfloor bird burial	Associated with Nesting Box 5, S wall (Di Peso et al. 1974:5:531, 534)
CG/246	CG(b)/360	Scarlet macaw	Whole	Plaza 3-12; BB/111	Subfloor bird burial	
CG/711	CG(b)/408B	Scarlet macaw	Whole	Plaza 3-12; BB/112-113	Subfloor bird burial	
CG/712	CG(b)/408C	Scarlet macaw	Whole	Plaza 3-12; BB/112-113	Subfloor bird burial	
CG/710	CG(b)/408A	Military macaw	Whole	Plaza 3-12; BB/112-113	Subfloor bird burial	
CG/29	CG(b)/407C	Scarlet macaw	Whole	Plaza 3-12; BB/114-115	Subfloor bird burial	
CG/30	CG(b)/407D	Scarlet macaw	Whole	Plaza 3-12; BB/114-115	Subfloor bird burial	
CG/31	CG(b)/407E	Scarlet macaw	Whole	Plaza 3-12; BB/114-115	Subfloor bird burial	
CG/296	CG(b)/407F	Scarlet macaw	Whole	Plaza 3-12; BB/114-115	Subfloor bird burial	
CG/27	CG(b)/407A	Macaw	Whole	Plaza 3-12; BB/114-115	Subfloor bird burial	

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/28	CG(b)/407B	Macaw	Whole	Plaza 3-12; BB/114-115	Subfloor bird burial	
CG/248	CG(b)/361B	Scarlet macaw	Whole	Plaza 3-12; BB/116	Subfloor bird burial	
CG/247	CG(b)/361A	Macaw	Whole	Plaza 3-12; BB/116	Subfloor bird burial	
CG/258	CG(b)/365A	Scarlet macaw	Whole	Plaza 3-12; BB/117	Subfloor bird burial	Associated with Nesting Box 4, E wall, SE corner (Di Peso et al. 1974:5:531, 534)
CG/257	CG(b)/365B	Scarlet macaw	Whole	Plaza 3-12; BB/117	Subfloor bird burial	Associated with Nesting Box 4, E wall, SE corner (Di Peso et al. 1974:5:531, 534)
CG/259	CG(b)/365C	Scarlet macaw	Whole	Plaza 3-12; BB/117	Subfloor bird burial	Associated with Nesting Box 4, E wall, SE corner (Di Peso et al. 1974:5:531, 534)
CG/244	CG(b)/357	Scarlet macaw	Whole	Plaza 3-12; BB/118	Subfloor bird burial	
CG/239	CG(b)/353	Macaw	Whole	Plaza 3-12; BB/119	Subfloor bird burial	Associated with Nesting Box 2, E wall, SE corner (Di Peso et al. 1974:5:531, 534)
CG/242	CG(b)/365A	Military macaw	Whole	Plaza 3-12; BB/120	Subfloor bird burial	Associated with Nesting Box 2, E wall (Di Peso et al. 1974:5:531)
CG/243	CG(b)/356B	Macaw	Partial	Plaza 3-12; BB/120	Subfloor bird burial	Associated with Nesting Box 2, E wall (Di Peso et al. 1974:5:529,
CG/245	CG(b)/359	Scarlet macaw	Whole	Plaza 3-12; BB/121	Subfloor bird burial	Associated with Nesting Box 1, NW corner (Di Peso et al. 1974:5:531, 534)
CG/240.1	CG(b)/354A	Scarlet macaw	Whole	Plaza 3-12; BB/122	Subfloor bird burial	Associated with Nesting Box 1, NW corner (Di Peso et al. 1974:5:531, 534)
CG/240.2	CG(b)/345B	Scarlet macaw	Whole	Plaza 3-12; BB/122	Subfloor bird burial	Associated with Nesting Box 1, NW corner (Di Peso et al. 1974:5:531, 534)
CG/282	CG(b)/378	Scarlet macaw	Whole	Plaza 3-12; BB/123	Subfloor bird burial	"Under entrance of Nesting Box 9" (Di Peso et al. 1974:5:534)
CG/101	CG(b)/165B	Scarlet macaw	Whole	Plaza 3-12; BB/124	Subfloor bird burial	
CG/100	CG(b)/165A	Macaw	Whole	Plaza 3-12; BB/124	Subfloor bird burial	
CG/103	CG(b)/182C	Scarlet macaw	Whole	Plaza 3-12; BB/125	Fill above floor	Killed accidentally (McKusick 1974:298)
CG/104	CG(b)/182D	Scarlet macaw	Whole	Plaza 3-12; BB/125	Fill above floor	Killed accidentally (McKusick 1974:298)
CG/105	CG(b)/182A	Macaw	Whole	Plaza 3-12; BB/125	Fill above floor	Killed accidentally (McKusick 1974:298)
CG/106	CG(b)/182B	Macaw	Whole	Plaza 3-12; BB/125	Fill above floor	Killed accidentally (McKusick 1974:298)

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/62.1	CG(b)/31G	Scarlet macaw	Whole	Plaza 5-12; BB/2	Subfloor bird burial	
CG.62.2	CG(b)/31H	Scarlet macaw	Whole	Plaza 5-12; BB/2	Subfloor bird burial	
CG/62.4	CG(b)/31I	Scarlet macaw	Whole	Plaza 5-12; BB/2	Subfloor bird burial	
CG/62.5	CG(b)/31J	Scarlet macaw	Whole	Plaza 5-12; BB/2	Subfloor bird burial	
CG/62.6	CG(b)/31K	Scarlet macaw	Whole	Plaza 5-12; BB/2	Subfloor bird burial	
CG/62.3	CG(b)/31D	Military macaw	Whole	Plaza 5-12; BB/2	Subfloor bird burial	
CG/62.7	CG(b)/31E	Military macaw	Whole	Plaza 5-12; BB/2	Subfloor bird burial	
CG/62.8	CG(b)/31F	Military macaw	Whole	Plaza 5-12; BB/2	Subfloor bird burial	
CG/73	CG(b)/33A	Military macaw	Whole	Plaza 5-12; BB/3	Subfloor bird burial	
CG/72	CG(b)/33B	Macaw	Whole	Plaza 5-12; BB/3	Subfloor bird burial	
CG/3	CG(b)/34A	Scarlet macaw	Whole	Plaza 5-12; BB/4	Subfloor bird burial	
CG/74	CG(b)/34B	Scarlet macaw	Whole	Plaza 5-12; BB/4	Subfloor bird burial	
CG/76.2	CG(b)/36B	Scarlet macaw	Whole	Plaza 5-12; BB/5	Subfloor bird burial	
CG/76.1	CG(b)/36C	Military macaw	Whole	Plaza 5-12; BB/5	Subfloor bird burial	
CG/75.1	CG(b)/35A	Scarlet macaw	Whole	Plaza 5-12; BB/6	Subfloor bird burial	
CG/4	CG(b)/35B	Scarlet macaw	Whole	Plaza 5-12; BB/6	Subfloor bird burial	
CG/75.2	CG(b)/35C	Macaw	Whole	Plaza 5-12; BB/6	Subfloor bird burial	
CG/78.2	CG(b)/38B	Scarlet macaw	Whole	Plaza 5-12; BB/7	Subfloor bird burial	
CG/78.1	CG(b)/38D	Military macaw	Whole	Plaza 5-12; BB/7	Subfloor bird burial	
CG/5	CG(b)/38A	Macaw	Whole	Plaza 5-12; BB/7	Subfloor bird burial	
CG/79	CG(b)/39A	Scarlet macaw	Whole	Plaza 5-12, BB/8	Subfloor bird burial	
CG/754	CG(b)/29H	Macaw	Whole	Plaza 5-12; BB/9	Subfloor bird burial	
CG/715	CG(b)/93	Macaw	Partial	Plaza 5-12	Floor contact	
CG/77.2	CG(b)/37B	Scarlet macaw	Partial	Plaza 5-12	Subfloor	
CG/77.1	CG(b)/37A	Military macaw	Partial	Plaza 5-12	Subfloor	
CG/70	CG(b)/32A	Scarlet macaw	Whole	Plaza 6-12; BB/1	Subfloor bird burial	"Fill against outside NE corner of Room 31-12" (Di Peso et al. 1974:5:541); near two single human burials (Burials 36-12, 37-12) but not associated
CG/68	CG(b)/32B	Scarlet macaw	Whole	Plaza 6-12; BB/1	Subfloor bird burial	"Fill against outside NE corner of Room 31-12" (Di Peso et al. 1974:5:541); near two single human burials (Burials 36-12, 37-12) but not associated

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/69	CG(b)/32E	Scarlet macaw	Whole	Plaza 6-12; BB/1	Subfloor bird burial	"Fill against outside NE corner of Room 31-12" (Di Peso et al. 1974:5:541); near two single human burials (Burials 36-12, 37-12) but not associated
CG/71	CG(b)/32C	Macaw	Whole	Plaza 6-12; BB/1	Subfloor bird burial	"Fill against outside NE corner of Room 31-12" (Di Peso et al. 1974:5:541); near two single human burials (Burials 36-12, 37-12) but not associated
CG/737	CG(b)/50B	Scarlet macaw	Partial	Plaza 6-12; Pit 10	Subfloor pit	
CG/738	CG(b)/50C	Scarlet macaw	Partial	Plaza 6-12; Pit 10	Subfloor pit	
CG/739	CG(b)/50D	Scarlet macaw	Partial	Plaza 6-12; Pit 10	Subfloor pit	
CG/740	CG(b)/50E	Scarlet macaw	Partial	Plaza 6-12; Pit 10	Subfloor pit	
CG/741	CG(b)/50F	Scarlet macaw	Partial	Plaza 6-12; Pit 10	Subfloor pit	
CG/742	CG(b)/50A	Military macaw	Partial	Plaza 6-12; Pit 10	Subfloor pit	
CG/743	CG(b)/50G	Macaw	Partial	Plaza 6-12; Pit 10	Subfloor pit	
CG/744	CG(b)/50H	Macaw	Partial	Plaza 6-12; Pit 10	Subfloor pit	
CG/745	CG(b)/50I	Macaw	Partial	Plaza 6-12; Pit 10	Subfloor pit	
CG/746	CG(b)/50J	Macaw	Partial	Plaza 6-12; Pit 10	Subfloor pit	
CG/714	CG(b)/86	Macaw	Partial	Plaza 6-12; Pit 7	Subfloor pit	
CG/758	CG(b)/52A	Scarlet macaw	Partial	Plaza 6-12; Pit 9	Subfloor pit	
CG/759	CG(b)/52B	Scarlet macaw	Partial	Plaza 6-12; Pit 9	Subfloor pit	
CG/760	CG(b)/52C	Scarlet macaw	Partial	Plaza 6-12; Pit 9	Subfloor pit	
CG/761	CG(b)/52D	Scarlet macaw	Partial	Plaza 6-12; Pit 9	Subfloor pit	
CG/757	CG(b)/52E	Macaw	Partial	Plaza 6-12; Pit 9	Subfloor pit	
CG/762	CG(b)/52F	Macaw	Partial	Plaza 6-12; Pit 9	Subfloor pit	
CG/763	CG(b)/52G	Macaw	Partial	Plaza 6-12; Pit 9	Subfloor pit	
CG/8	CG(b)/56A	Scarlet macaw	Whole	Room 17-12; BB/1	Fill above floor	Killed accidentally (McKusick 1974:298)
CG/95	CG(b)/137	Military macaw	Whole	Room 7-13; BB/1	Subfloor bird burial	
CG/844	CG(b)/207B	Macaw	Partial	Plaza 4-14	Floor contact	
CG/304	CG(b)/430	Macaw	Partial	Room 41-14	Floor contact	
CG/853	CG(b)/507A	Thick-billed parrot	Partial	Room 45-14	Floor contact	
CG/114	CG(b)/269	Scarlet macaw	Partial	Plaza 1-15/S Street	Fill above floor	
CG/238	CG(b)/352A	Macaw	Partial	Room 30-16	Floor contact	
CG/302	CG(b)/418C	Scarlet macaw	Whole	Room 31-16; BB/1-5	Subfloor bird burial	
CG/301	CG(b)/418D	Scarlet macaw	Whole	Room 31-16; BB/1-5	Subfloor bird burial	

Identifier	Secondary Id.	Taxa	Completeness	Location	Context	Remarks
CG/300	CG(b)/418F	Scarlet macaw	Whole	Room 31-16; BB/1-5	Subfloor bird burial	
CG/299	CG(b)/418G	Scarlet macaw	Whole	Room 31-16; BB/1-5	Subfloor bird burial	
CG/303	CG(b)/418A	Military macaw	Whole	Room 31-16; BB/1-5	Subfloor bird burial	
CG/298.1	CG(b)/418E	Military macaw	Whole	Room 31-16; BB/1-5	Subfloor bird burial	
CG/305	CG(b)/445A	Scarlet macaw	Whole	Room 2-18 Platform; BB/1	Subfloor bird burial	"Room 2-18 Platform, E side" (Di Peso et al. 1974:5:790)
CG/306	CG(b)/445B	Scarlet macaw	Whole	Room 2-18 Platform; BB/1	Subfloor bird burial	"Room 2-18 Platform, E side" (Di Peso et al. 1974:5:790)
CG/307	CG(b)/445C	Scarlet macaw	Whole	Room 2-18 Platform; BB/1	Subfloor bird burial	"Room 2-18 Platform, E side" (Di Peso et al. 1974:5:790)
CG/308	CG(b)/445D	Scarlet macaw	Whole	Room 2-18 Platform; BB/1	Subfloor bird burial	"Room 2-18 Platform, E side" (Di Peso et al. 1974:5:790)
CG/309	CG(b)/445E	Scarlet macaw	Whole	Room 2-18 Platform; BB/1	Subfloor bird burial	"Room 2-18 Platform, E side" (Di Peso et al. 1974:5:790)
CG/310	CG(b)/445F	Scarlet macaw	Whole	Room 2-18 Platform; BB/1	Subfloor bird burial	"Room 2-18 Platform, E side" (Di Peso et al. 1974:5:790)
CG/315	CG(b)/475B	Scarlet macaw	Whole	Plaza 1-21; BB/2	Floor contact	Killed accidentally (McKusick 1974:298)
CG/313	CG(b)/467A	Scarlet macaw	Whole	Plaza 1-21; BB/3	Floor contact	Killed accidentally (McKusick 1974:298)
CG/314	CG(b)/467B	Scarlet macaw	Partial	Plaza 1-21; BB/3	Floor contact	Miscellaneous remains (McKusick 1974:306)
CG/311	CG(b)/466A	Scarlet macaw	Whole	Plaza 1-21; BB/4	Floor contact	Killed accidentally (McKusick 1974:299)
CG/312	CG(b)/466B	Macaw	Whole	Plaza 1-21; BB/4	Floor contact	Killed accidentally (McKusick 1974:299)
CG/317	CG(b)/508C	Scarlet macaw	Whole	Near Plaza 1-21; BB/1-21	Subfloor bird-human burial	Associated with Burial 4-21
CG/316	CG(b)/508D	Scarlet macaw	Whole	Near Plaza 1-21; BB/1-21	Subfloor bird-human burial	Associated with Burial 4-21
CG/882	CG(b)/657	Macaw	Partial	SW of Room 3-22	Fill above floor	"Plaza 1-15 was open area located S of Unit 14 and N of Unit 15 house-cluster; stripped to study relationship of these units and to expose S Street. Aeolian and waterlain deposits removed, but plaza not entirely excavated; test trenches dug" (Di Peso et al. 1974:5:713