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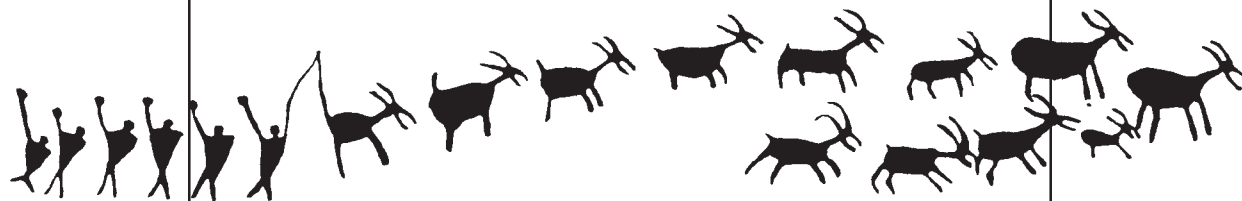
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# Effect of Enrichment Items on the Aggression and Competition Levels of Captive Orangutans

ELIZABETH VALDOVINOS

*ABSTRACT: This paper explores competition among captive orangutans at the Sacramento Zoo. Novel food and non-food enrichment items were introduced into the orangutan exhibit and the resulting competitive behaviors were recorded. Baseline data were compared to the experimental condition. Hypotheses are that: 1) the orangutans would exhibit a higher number of aggressive behaviors during the experimental conditions; and 2) the individual orangutans would differ in both the frequency of aggressive behaviors and the competitiveness of those behaviors in each of the study conditions. Results indicated that the orangutans were not more aggressive in the study conditions; however, there were differences in the level of competitiveness among the individuals, specifically showing a higher level of competitiveness in the food enrichment condition.*

## INTRODUCTION

This project examines the effects of enrichment on the three captive Sumatran orangutans (*Pongo pygmaeus abelii*) at the Sacramento Zoo with the intention of gaining an understanding of aggressive and competitive behavior. Research has demonstrated that introducing enrichment items into enclosures stimulates captive animals' natural behavior (Anderson and Chamove 1983; Baker 1999; Bitnoff 1996; Dewey 1989; Markowitz 1982; Reinhardt 1993). Captive animals may be restricted from their species-typical behavior, thus enrichment can help alleviate boredom and aberrant behavior. Generally, captive orangutans are not placed in similar social groupings as they experience in the wild. Orangutans in the wild live semisolitary lives, where aggregations occasionally occur, usually in large food patches or in a mating context (Utami et al. 1997). Competition occurs among wild orangutans, especially during food scarcity (Utami et al. 1997), thus it is expected that aggression and competition will occur among the captive orangutans at the Sacramento Zoo for the enrichment items. The

social behavior of orangutans (Bramblett 1994; Hamilton and Galdikas 1994; Rodman 1988; Tobach et al. 1989; Utami et al. 1997; VanSchaik and Van Hooff 1996), as well as competition among other animals (Colegrave 1994; Gause 1964; Hammerstein 1998; Jones 1980; Maier 1998; Mason and Mendoza 1993; Moynihan 1998; Riechert 1998), have been studied in depth; however, I am unaware of any literature addressing competition among captive orangutans.

## RELEVANT BACKGROUND AND THEORY

### GAME THEORY

In general, game theory predicts behavior for many animal groups. Game theory, derived from economics, is used to explain competition as the force behind economic efficiency and adaptation. In biology, it is used to explain the evolutionary process of competition for survival and reproduction (Hammerstein 1998). Game theory evaluates whether an animal will behave as an ally or a traitor, i.e., whether they are expected to cooperate or compete (Strier 2000), and is used to predict optimal outcomes of inter-

actions between animals (Maier 1998). Maynard Smith (1973, 1974) applied game theory to explain how animals develop strategies that take into account their competitors' behaviors. Animals in competition for limited resources must take into consideration a competing animal's behavior (Maier 1998), and the costs and benefits of their behavior. In an evolutionary stable strategy, individuals could follow the "tit-for-tat" rule of cooperation and altruism (Strier 2000). For example, in many primate societies, low ranking members often groom higher ranking members for a longer amount of time (Strier 2000). The high ranking members may in turn help their subordinates. However, if one fails to reciprocate, retaliation may result in the form of direct attacks (Strier 2000).

Hammerstein (1998:4) describes a classical game as "a model in economic decision theory describing the potential interactions of two or more individuals whose interests do not entirely coincide." When there is disagreement on the use of a limited resource, there is competition. If food is substituted for a limited resource, the theory can be applied to animal behavior since it still refers to costs and benefits for survival. Maynard Smith and Price (1973) note that some animals develop a strategy of ritualized fighting (i.e., threat displays) or escalated fighting (i.e., behavior capable of injuring an opponent), and they conclude that the evolutionarily stable strategy is to be capable of responding to escalation from an opponent with escalation. Reichert (1998:65) concludes that "game theory has demonstrated that animal conflict can be explained in terms of individual costs and benefits."

Conflicts, or contests, can often be settled without escalated fighting after an initial assessment phase (Reichert 1998). Individuals gain information on potential character states, such as experience, size,

age, and sex, which might determine the outcome of the contest without actual fighting (Reichert 1998). These states give an individual a greater resource-holding power than its opponent (Reichert 1998). A difference in payoff, relative to what its opponent would achieve, is another factor that would have to be assessed. Reichert (1998) states that payoffs influence the level of fighting that individuals are willing to engage in. If the payoff value is high, then escalated fighting is predicted, regardless of other factors that might influence the outcome.

#### *AGGRESSION AND COMPETITION LITERATURE*

There is a large volume of research addressing competition among animals. Moynihan (1998:4) defines competition as "whenever one individual occupies or pre-occupies a resource that would otherwise be available to, and possibly or probably be appropriated by, another individual of the same or another species." Competition occurs over limited resources, such as food, mates, territory, and group membership (Colegrave 1994; Jones 1980; Maier 1998; Reichert 1998). When an individual impinges on the interests of another, conflict results and aggression accompanies it (Mason and Mendoza 1993). Aggression "includes overt attack in all its forms, ranging from violent blows or strikes to simple intention movements, such as friendly advances toward a rival or opponent" (Moynihan 1998:5). Aggression is also an adaptation that allows an animal to cope with competition (Moynihan 1998), and is a product of circumstances (Jolly 1972).

Social animals employ different competitive strategies. According to Mason and Mendoza's (1993) Minimax Model, individual primates strive to have their own way wherever they can; primates want to move freely

within the group; interact with whomever and whatever; they want unimpeded access to goods; and to accomplish all with as little pain as possible. Individuals are looking to maximize satisfaction while minimizing discomforts and frustration (Mason and Mendoza 1993).

In closed systems, such as zoos, animals have the choice of how to compete, but not of leaving the area, thus they are unable to avoid competition (Colegrave 1994). They can accept the presence of others and compete passively, or they can actively try to exclude others (Colegrave 1994). The latter is a common mechanism of resource defense called direct competition. Direct competition differs from exploitation competition where better competitors take more of the limiting resource (Riechert 1998). The crux of the aggressive competition theory is whether it is more beneficial for an animal to behave passively or aggressively.

#### AGGRESSIVE COMPETITION THEORY

Popp and DeVore (1979) state that aggressive competition will occur when the benefits of taking possession of the disputed resource outweigh the costs to the actor, and if it is in the actor's own evolutionary interests to behave aggressively. An actor will try to increase its competitor's effort while reducing its own effort for gaining the disputed resource, thus making it unprofitable and maladaptive for the opponent to gain access to the resource (Popp and DeVore 1979).

The first individual to terminate its aggressive behavior is the *loser*; the last individual to terminate its aggressive behavior will normally gain access to the resource and be defined as the *winner*. Natural selection will favor those individuals who develop defensive strategies, i.e., behaviors that are less costly than fighting. Popp and DeVore (1979)

conclude that as a result, it is not necessary for an aggressive actor to inflict physical injury on an opponent for the actor's behavior to be adaptive; it is sufficient that the actor force his opponent to adopt a defensive strategy that is costly in time and energy.

#### RELATED HYPOTHESES

Hypotheses related to game theory are the hawk and dove strategies, and conditional strategies. The hawk and dove strategies relate to intraspecies confrontations over resources where the hawk strategy is to fight, and the dove strategy is to back off (Maier 1998). Maier (1998) goes on to explain that if there were several doves, there would be an advantage to becoming a hawk as it could win every encounter. As the number of hawks increased, the chance of having an encounter with another hawk would increase and the possibility of losing a fight would be costly. In this scenario, there would be an advantage to remaining a dove because an encounter with a hawk will only involve minimal loss. Although the animal will lose the resource, but it will not be injured or spend time fighting (Maier 1998). The participants in the hawk-dove game play the role they choose or the role they inherit (Cushing 1995). As suggested by game theory, if a dove is aware of its opponent and can determine its opponent's intentions, a dove can and will avoid a hawk (Cushing 1995). However, if a dove retreats, it does not necessarily mean that the hawk is the winner. As long as the dove remains in the vicinity of the hawk, then it could still represent a potential competitor (Cushing 1995).

In conditional strategies, an animal may fight when there is a good chance of winning, but back off when there is a significant chance of losing. Threats and bluffs enhance the effectiveness of a conditional approach, and prevent an opponent from

anticipating at what point the animal will back down (Maier 1998).

The above theories and strategies for aggressive and competitive behavior provide a basis for studying competition among orangutans. In order to understand captive orangutan social behavior, aggression, and competition, it is necessary to draw parallels with their wild counterparts.

### *WILD ORANGUTAN BEHAVIOR*

Wild orangutans have three social modes: adult females and their offspring; solitary adult males; and juvenile groups (Tobach et al. 1989). Orangutans live semisolitary lives, but come together only occasionally for food and mating (Hamilton and Galdikas 1994; Utami et al. 1997). Females tend to be solitary and the strongest social relationship is the mother-offspring dyad (Van Schaik and Van Hooff 1996). When it is not fruiting season, adult males are also solitary. Their ranges are neither exclusive nor stable and the resident male is not necessarily the dominant male (Van Schaik and Van Hooff 1996). Orangutans have a roving male promiscuity system, where males have large overlapping areas where they can search for receptive females (Van Schaik and Van Hooff 1996).

Three types of aggregations occur in the wild: travel bands, temporary aggregations, and consorts (Utami et al. 1997). The first two aggregations are related to different food availabilities (Utami et al. 1997). During periods of food scarcity, orangutans may experience competition for food. Two types of food competition occur within groups: scramble competition, which results in smaller benefits for individuals in larger groups; and contest competition, which leads to larger benefits for dominant individuals (Utami et al. 1997). Wild orangutans in temporary aggregations experience

contest, but not scramble, competition (Utami et al. 1997; Van Schaik and Van Hooff 1996). Utami et al. (1997) found that few displacements occurred between adult males in large fig trees; however, displacements between adult females occurred. These scientists also stated that all adult males were dominant over all subadult males and adult females; although, the presence or absence of a dominant individual did not significantly affect the foraging behavior of subordinate individuals (Utami et al. 1997).

Orangutans need large amounts of food; however, they are selective feeders (Van Schaik and Van Hooff 1996). Fruits dominate orangutans' diet, and they prefer fruit over leaves and bark (Rodman 1988; Van Schaik and Van Hooff 1996). They have been observed eating soil, insects, and eggs (Barbiers 1985). Orangutans deplete all ripe fruit at one source and they compete for food if they forage together, especially among large adult males (Hamilton and Galdikas 1994). Orangutans generally spend more than 95% of their waking hours feeding, resting, and moving between feeding and resting sites (Rodman 1988). Morning and evening feeding peaks are in fruiting trees, and afternoon feedings are on leaves during afternoon travel periods (Rodman 1988).

### *CAPTIVE ORANGUTAN BEHAVIORS*

Captive orangutans obviously do not need to spend time foraging and their movement is generally restricted. Several researchers have studied activity levels and social behaviors of captive orangutans. While some primate species perform aberrant behaviors in limited captive environments, orangutans are not noted for abnormal stereotypes; however, they consistently exhibit low activity levels and high obesity levels (Wright 1995). In observing orangutans at the Cheyenne Mountain Zoo in Colorado Springs,

Colorado, it was discovered that novel items reduced lethargy in the primates (Wright 1995). Object manipulation, investigation and play behavior occurred at a high level during the enrichment times for the orangutans, when compared to their activity during baseline and follow-up (Wright 1995). Idle behavior decreased during the experimental phases, but later increased during follow-up observations. Wright (1995) suggests that “behavioral rebound” could be avoided if novel enrichment is continued.

Tripp (1985) found that the orangutans’ activity increased at the Topeka Zoo in Kansas after adding manipulable material to the exhibit. The orangutans were exposed to three conditions. The orangutans were least active during the bare exhibit (baseline) condition, activity increased when manipulable materials were introduced, and the orangutans were most active when edibles were tossed into the exhibit with manipulable items present (Tripp 1985). Manipulation and locomotion behaviors increased for most of the orangutans.

Perkins (1992) observed captive orangutans in nine zoological parks in the southeastern United States in an attempt to identify and quantify which enrichment items specifically influenced the primates’ activity levels. She discovered that a large enclosure is part of a “set of related variables” that increases orangutan activity. The large space allows for more animals and more “play-things”, or movable objects. Perhaps movable objects are more appealing to orangutans because they resemble branches and vines used in the wild (Perkins 1992). Wild orangutans are solitary animals, but in captivity orangutans are not required to forage for their food (Perkins 1992), thus their social behaviors change in captivity. Perkins (1992) maintains that orangutans are quite capable of forming steadfast social attachments.

At the Sedgwick County Zoo in Wichita, Kansas, Tobach et al. (1989) observed social interactions among their captive orangutans. The researchers found that with their study group, the adult female orangutans had a complex relationship, and the male was found in a number of social dyads, both of which are contrary to their wild counterparts’ social behavior (Tobach et al. 1989). Given their captive circumstances, the adult animals associated with each other more than in their natural habitat (Tobach et al. 1989).

Poole (1987) also concluded that captive orangutans chose to make social relationships different than those they would have in the wild. Orangutans were observed on an artificial island at the Singapore Zoological Gardens in order to examine their social behavior. The island provided for high levels of potential social contact, which are opposite from their wild state. Results were as follows: older male orangutans spent more time alone, but spent more time in proximity to other individuals; social play was exhibited mostly by adult females and juveniles, but rarely by adult males; adult females groomed most often; play relationships were between adolescents and subadults; and there was no obvious dominance hierarchy and no aggression (Poole 1987). Poole (1987) suggests allowing captive orangutans the opportunity to form social groups if they choose to do so, as it creates an enriched environment.

The above studies suggest that orangutans in captivity can be socially flexible compared to their wild counterparts, and that enrichment items appear to promote positive activities.

#### *ENRICHMENT LITERATURE*

In order to better understand this project, it is important to know about the

background and purpose of introduced items, or enrichment. Early primate research was conducted to understand human psychological processes as well as primate anatomy (Bramblett 1994). Concerns about animal welfare emerged from these early primate studies. The Animal Welfare Act, amended in 1985, by the U.S. Congress required primate researchers to promote animals' psychological well-being (Novak and Suomi 1988). Psychological well-being can be assessed from physical health and fecundity (Wright 1995). It is difficult to define well-being, but it is generally accepted that non-human animals can experience suffering. Primatologists who study captive groups face ethical issues during research, primarily that the animals are kept in an unnatural, confined environment and may demonstrate behaviors different from those expressed in natural habitats.

Enrichment is "the act of making something better by the addition, or increase, of some desirable quality, attribute, or ingredient" (Guerrero 1997:1). A number of researchers (Anderson and Chamove 1983; Baker 1999; Barbiers 1985; Bitnoff 1996; Dewey 1989; Markowitz 1982; Perkins 1992; Reinhardt 1993; Tripp 1985; Wright 1995) have shown that enrichment benefits captive primates by reducing abnormal behaviors and increasing normal activity. Normal primate behaviors refer to those observed in the wild.

Another purpose of enrichment for captive orangutans is to allow them to behave more like free-ranging orangutans, since they are restricted from their full range of normal behaviors observed in the wild. Thus, it is important to provide a captive environment where animals can choose, even on a limited basis, various aspects of their environment (Cocks et al. 1999; Markowitz 1982) while increasing activity.

Current orangutan enrichment at the

Sacramento Zoo includes the following: 1) scatter food (vines, dried nuts and fruits, seeds, puffed wheat or rice, and popcorn), 2) coconuts, or other seasonal fruits/vegetables, 3) frozen fruit, 4) clothes, 5) boxes, 6) bamboo, and 7) sheets and towels (personal communication with Leslie Field and Lynette Elia). The Sacramento Zoo keepers get enrichment ideas from other keepers and volunteers (personal communication with Leslie Field).

Introducing novel items into captive primates' enclosures provides a means to enrich captive animals. Although this paper is not addressing well-being, the inclusion of introduced items provides an avenue for observing captive behavior, such as aggression and competition, while enriching the study group's lives. It is anticipated that because enrichment has been shown to increase activity and manipulation, as well as reduce lethargy in captive orangutans (Tripp 1985, Wright 1995), that competitive behavior and aggression levels will also increase during the enrichment phase.

#### *HYPOTHESES*

The effects of aggression and competition among the Sacramento Zoo orangutans were observed after introducing enrichment items into their enclosure. This paper addresses the question: *Do the orangutans at the Sacramento Zoo compete for enrichment items as wild orangutans do for food, and if so, do they compete more for food or non-food enrichment?* In an artificial environment, such as the Sacramento Zoo, there is not an overt need to aggressively compete for resources (e.g., food, mates, and territory). Competition may take on a subtle form in relation to enrichment items because orangutans are subtle in their behaviors (personal communication with Leslie Field).

I observed the orangutans at the Zoo during their normal condition, i.e., baseline condition, when they did not have any introduced items in their enclosure. I then compared the baseline condition to the experimental conditions, when the orangutans received introduced items in their enclosure. My hypotheses are as follows: 1) baseline hypothesis - overall, the orangutans will exhibit a higher number of aggressive behaviors during both the food and nonfood enrichment conditions than during the baseline conditions and, 2) aggressive and competitive behavior hypothesis - the individual orangutans will differ in both the frequency of their aggressive behaviors, and the competitiveness of those behaviors in each of the study conditions. Enrichment items may take on a similar meaning that highly prized food items do for wild orangutans (where dominance, status, age, sex, access to mates, and sharing are factors) because enrichment items are novel and rare. I believe the items *and* the resulting aggressive and competitive behavior for the items will serve as enrichment for the orangutans. Introducing items into the orangutan enclosure provides an avenue for observing captive aggressive and competitive behavior.

## MATERIALS AND METHODS

### *SUBJECTS*

Observations were made on the three orangutans housed at the Sacramento Zoo (see Table 1). To understand the orangutans' aggressive and competitive behaviors, it is necessary to learn the orangutans' backgrounds and interactions. The information was obtained from Zookeeper, Lynette Elia, and lead keeper/supervisor over mammals, Leslie Field.

**Table 1 Sacramento Zoo Orangutan Profiles<sup>†</sup>**

Name	Sex	Origin	Date of Birth	Health Conditions	Weight
Urban Ginger	M	Sacramento Zoo	Feb. 1981	none	252 lbs.*
	F	wild caught	approx 1955	arthritis	110 lbs.**
Sayang	F	Sedgewick County Zoo	Nov. 1983	none	102 lbs.***

<sup>†</sup>(personal communication with Leslie Field and Lynette Elia)

\*December 1999

\*\*February 2000

\*\*\*January 2000

The orangutans' enclosure consists of an open-air exhibit, while their sleeping dens are inside, behind the scenes. The orangutans are fed inside between 8:00-8:30 A.M., and at 4:00 P.M. when they are brought back inside. Their daily enrichment items are already in the open-air exhibit when the animals are released at approximately 9:00 A.M. Occasionally, enrichment items are thrown into the open-air exhibit for special occasions or presentations.

### *PROCEDURES*

In order to collect baseline behaviors, I observed the orangutans for 15 hours during September 2000. For the experimental phase, I constructed the enrichment items following the Zoo's guidelines and approved projects. Food items included: frozen water and juice blocks with fruit, boxes with browse materials, frozen peanut butter tubes, frozen yogurt tubes, raisin boards, frozen apple sauce tubes, Jell-O tubes, peanut butter "sandwiches" (made from cardboard), marshmallow "kabobs", unshucked corn cobs, tangerines in socks sprinkled with cinnamon, apple sauce and raisins in PVC pipe, seeds, and wrapping paper tubes with browse items (see Table 2). Non-food items included: socks with extract essences, socks with tea, flowers in socks, boxes, toilet paper roll "necklaces", pillow cases sprinkled with cinnamon in boxes, sheet "hammocks", and hats (see Table 2). The Zookeepers distrib-

uted the items to the orangutans, usually by throwing the items into the enclosure or by placing them in the exhibit before the animals were released, as I observed and recorded the animals' behaviors. All of the orangutans were together when exposed to the enrichment items. A schedule was created with predetermined, alternating days of when and what items were to be introduced. I collected 21 hours of experimental data during September – November 2000.

**Table 2 List of Enrichment Items Used**

<b>Food Enrichment Items:</b>
Frozen blocks (water) with grapes
Boxes with browse (popcorn and raisins)
Frozen peanut butter tubes (in paper towel rolls)
Frozen yogurt tubes (in paper towel rolls)
Raisin boards (2"x4"x6" of Douglas fir with drilled holes and raisins in holes)
Frozen blocks (diluted Kool-Aid) with apples
Frozen apple sauce tubes (in paper towel rolls)
Jell-O tubes (PVC pipe with caps on ends and holes drilled in pipe, with gelatin inside)
Peanut butter "sandwiches" (in square cardboard pieces)
Marshmallow "kabobs" (marshmallows skewered on sticks)
Unshucked corn cobs
Tangerines in socks sprinkled with cinnamon
Apple sauce in PVC pipe with raisins plugged in holes
Seeds spread on ground outside
Wrapping paper tubes with browse items
<b>Non-food Enrichment Items:</b>
Socks with extract essences in knots
Socks with tea inside
Flowers in socks
Boxes
Toilet paper roll "necklaces" (rolls on twine)
Pillow cases sprinkled with cinnamon inside boxes
Sheet "hammocks" (sheets tied to resemble hammocks)
Sombreros

In order to test the aggressive behaviors, I observed the orangutans using continuous recording of specific aggressive behaviors (aggressive display, approach, beg, take, and temper tantrum).

A scale from 0-4 was used to determine the level of competition (see Table 3). The competition scale scores for levels of contact among animals; however, competition can be inferred in a subjective manner. As previously discussed, in closed systems, such as zoos, animals are often unable to avoid competition, but they can choose to

compete passively or actively (Colegrave 1994). For example, in the hawk-dove hypotheses (Cushing 1995), an animal that remains nearby another individual could still represent a potential competitor. Thus, the mere proximity of another animal could be competitive behavior. Goodall (1986) states that the most common overt competitive behavior is when one chimpanzee approached another who promptly left the feeding place. When I scored for competitive interactions, competition began when one orangutan displayed interest in another's item that was introduced into the enclosure. The competitive interaction ended when one orangutan attained the desired item and left, or gave up after unsuccessfully taking the item and moving away a significant distance. Levels 0-1 indicate no competition; levels 2-4 indicate competition. When orangutans continued competing for the item, the competitive interactions were continually scored. The individual instigating the interaction and who received the interaction was recorded.

**Table 3 Level of Competition**

Competition Level	Description
0	orang appears to have to interest in introduced item
1	orang looks over at other orang with item and looks away
2	orang approaches other orang with item and looks intently at item
3	orang approaches other orang and tries to take item
4	orang takes item from other orang

## DATA ANALYSIS

For the baseline hypothesis (the orangutans would exhibit a higher number of aggressive behaviors during both the food and nonfood enrichment conditions than during the baseline conditions), the independent variable was the study condition with the following three levels: 1) baseline, 2) food enrichment, and 3) non-food enrichment. The dependent variable was the average rate of aggressive behaviors observed per 30

minutes. The data for this hypothesis were analyzed using a one-way analysis of variance (ANOVA). For the aggressive and competitive behavior hypothesis (the orangutans would differ in both the frequency of their aggressive behaviors and the competitiveness of those behaviors in each of the study conditions), the independent variable was the individual orangutans: 1) Urban, 2) Ginger, and 3) Sayang. The dependent variables were the average competitiveness score of each orangutan (as measured by the level of competition rating scale) and the number (frequency) of initiating aggressive behaviors. A series of three one-way ANOVA's (one for each study condition) was used to determine if the orangutans differed qualitatively in their competitiveness in each study condition. Tukey multiple comparisons were used for post hoc tests whenever significant ANOVA was found. Similarly, a series of three Chi Square Goodness-of-fit tests were used to determine if the orangutans differed in the number of aggressive acts each engaged in for each study condition. An alpha level of 0.05 significance was selected *a priori*. The statistical package SPSS (version 10.0) was used to analyze data.

## RESULTS

### BASELINE HYPOTHESIS

The mean number of aggressive behaviors per 30 minutes for the baseline, non-food enrichment, and food enrichment conditions was 4.00 ( $SD = 3.76$ ), 4.70 ( $SD = 2.96$ ), and 4.00 ( $SD = 3.25$ ), respectively. The ANOVA results did not indicate a significant difference in the overall rate of aggressive behaviors across the three study conditions,  $F(2, 72) = 0.39$ ,  $p > .05$ , where  $p = .68$ . These results do not support the baseline hypothesis that enrichment items would result in significantly more overall

aggressive behaviors in the orangutans. Although there appeared to be slightly more aggression during the non-food enrichment condition than during the other two study conditions, the differences among them did not reach statistical significance and hence cannot be considered "real" differences.

### AGGRESSIVE AND COMPETITIVE BEHAVIOR HYPOTHESIS

The results of the series of the Chi Square tests for the baseline [ $c^2(2, N = 118) = 80.56$ ,  $p > .05$ ] food enrichment [ $c^2(2, N = 139) = 24.09$ ,  $p > .05$ ], and non-food enrichment [ $c^2(2, N = 60) = 24.30$ ,  $p = .04$ ] conditions all indicated that at least one orangutan had a higher number of aggressive behaviors than did the other orangutans. These findings support the aggressive and competitive behavior hypothesis.

The number of aggressive acts each orangutan engaged in for each study condition is presented in Table 4. Specifically, regardless of the study condition, Sayang engaged in a higher number of aggressive behaviors than did either Ginger or Urban. Ginger and Urban did not differ significantly in their numbers of aggressive behaviors in any of the study conditions. In terms of the frequency of initiating aggressive behaviors, Sayang was consistently more aggressive than either Urban or Ginger.

**Table 4**  
Number of Aggressive Acts of each Orangutan for each Study Condition

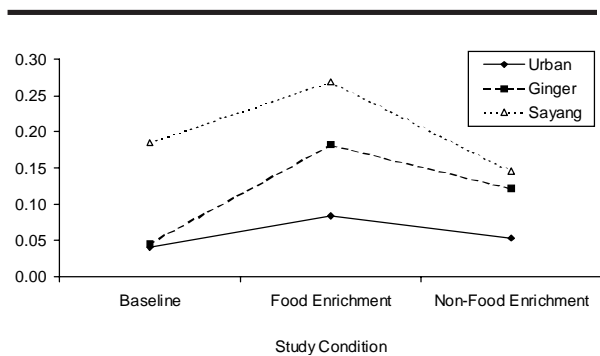
Orangutan	Baseline	Enrichment		
		Food	Non-Food	Total Enrichment
Urban	12	38	11	49
Ginger	21	27	11	38
Sayang	85	74	38	112

**Table 5**  
**Mean and Standard Deviation Competitiveness Score of each Orangutan for each Study Condition**

Orangutan	Enrichment					
	Baseline		Food		Non-Food	
	M	SD	M	SD	M	SD
Urban	0.04	0.36	0.08	0.53	0.05	0.42
Ginger	0.05	0.42	0.18	0.64	0.12	0.55
Sayang	0.19	0.74	0.27	0.86	0.15	0.66

The mean and standard deviation competitiveness ratings of each orangutan for each of the study conditions are presented in Table 5. The results of the ANOVA for the baseline condition indicated that at least one orangutan was more competitive than at least one of the others,  $F(2, 2454) = 21.77, p < .05$ . Results of Tukey post hoc tests indicated that Sayang was more competitive than both Urban and Ginger ( $ps < .05$ ), and that Urban and Ginger did not significantly differ in their level of competitiveness ( $p > .05$ ). Results of the ANOVA for the food enrichment condition also indicated that at least one orangutan was more competitive than at least one of the others,  $F(2, 2652) = 14.76, p < .05$ . Tukey post hoc tests showed that Sayang was again more competitive than both Urban and Ginger ( $ps < .05$ ). However, the results also indicated that Ginger was more competitive than Urban during food enrichment ( $p < .05$ ). As such, Urban was the least competitive, Ginger was in the middle, and Sayang was the most competitive. The non-food enrichment ANOVA also indicated a difference in the orangutans' competitiveness,  $F(2, 1305) = 3.41, p < .05$ . The post hoc tests showed that Sayang was more competitive than Urban ( $p < .05$ ), but was not more competitive than Ginger ( $p > .05$ ). In addition, Ginger and Urban also did not differ in their level of competitiveness during non-food enrichment ( $p > .05$ ). The relationship between the means is illustrated in Figure 1.

**Figure 1**  
**Mean competitiveness of each orangutan in each study condition**



Overall, these results indicate that Ginger was more active during the enrichment conditions than during baseline, that Urban's behavior did not change much relative to the other orangutans (he was always the least competitive), and that Sayang was always highly competitive relative to the others (although equally as competitive as Ginger during non-food enrichment), as measured by both the quantity of aggressive behaviors and the competitive quality of those behaviors.

## DISCUSSION

There were differences in the relative levels of competitiveness of the orangutans across the different study conditions, specifically showing a higher level of competitiveness in the food enrichment condition. Urban never became more competitive, but Sayang was always competitive. Ginger changed her intensity, but not frequency, of competitiveness depending upon the condition. During the baseline condition, Ginger was just as uncompetitive as Urban; however, during the non-food enrichment condition, Ginger's competitiveness increased, and during the food enrichment condition, her level of competitiveness was significantly higher than Urban's. But Ginger was still less competitive than Sayang in both frequency

and quality in all conditions except non-food enrichment.

Perhaps Sayang's competition scores were always high because her general activity was high, possibly because she is young and energetic. Although Urban is only two years older than Sayang, her activity level was higher than Urban's, possibly due to other factors, such as sex differences. For example, Tobach et al. (1989) found that among their captive study group, the orangutan males were idle and solitary. Compared to Ginger, Sayang's youth could possibly be a factor that made her a better competitor. It was mentioned previously that while Ginger is older than Sayang, she is more playful (personal communication with Field); however, during my observations, I noticed Sayang was more active and playful than Ginger. It appeared that Sayang's defensive strategy was to take, steal, and hoard enrichment items (i.e., resources). She collected all enrichment items regardless of what they were, even if she had her own. Sayang did not necessarily try to actively exclude others, rather she accepted the presence of others and competed somewhat passively, because the others allowed her to. Perhaps Sayang was able to assess the character states (e.g., experience, size, age, and sex) of Ginger and Urban and knew when she could take advantage of a situation (i.e., take or steal items). It was Sayang's lower level of competitiveness, paired with a slight increase in Ginger's competitiveness that accounts for the fact that the results showed them to be equally aggressive during non-food enrichment.

Ginger's old age could account for her low competition scores; however, her competition increased relative to the others during both of the enrichment conditions. Ginger employed a different competitive strategy than Sayang. In the hawk and dove strategies previously discussed, Ginger is a

dove. The dove's strategy is to back off, even if it costs the individual the resource. Ginger cannot afford to lose energy and time struggling over a resource, so she generally succumbed to the others. She seemed to know when to back off, especially when there was a chance of losing. When it came to food, however, Ginger's competition level increased because it was in her own evolutionary interests to behave more competitively.

Urban can also be considered a dove as he was generally passive. In some instances, he was overtly aggressive, hovering over the females or charging for the items, but it was not a significant amount to affect his competition score. Urban spent a large amount of time idle and solitary, which is typical of both wild and captive orangutans. Thus his low competition level should not be surprising. Perhaps the items were not sufficiently enticing or complicated to increase his competition scores in the enrichment conditions. Urban was more interested in the food enrichment items, although it is not reflected in his scores. He generally came out from under his box in the cave just to eat or inspect the items, then usually returned to his former position. Perhaps Urban has not had to deal with other males who were competing with him for female attention (personal communication with Kristina Casper-Denman), which may account for his general idle behavior.

There were other behaviors that occurred during the observation sessions that could not be scored, but were noted, such as walking, climbing, playing, foraging, etc. Since this study focuses on aggressive competition, only specific behaviors were recorded. Readers should not be biased that Urban and Ginger are usually idle just because their aggression and competition scores were low in this particular study; all orangutans performed active behaviors.

There were also aggressive and competitive behaviors that occurred but could not be scored because they were not occurring during the timed interval. Another subject to consider is sharing, which occurred but was not recorded. The act of taking an item was scored, but some instances could have been considered sharing.

Tobach et al. (1989) and Poole (1987) found the orangutans' were capable of being socially flexible compared to their wild counterparts, as I also noted. While Urban is mostly solitary, he has contact with Sayang and Ginger, which would not generally happen in the wild. Females are also solitary in the wild, yet Ginger and Sayang have almost constant interactions. The enrichment items seemed to provide an avenue for which the orangutans could interact, and for which their flexible social behavior could be observed.

It is difficult to describe primate behavior, especially without anthropomorphizing - a common issue in anthropology. However, there is substantial information that the emotional physiological states of other primates are homologous to humans (Harlow 1958, Harlow and Mears 1979). It is safe to say from the data at hand that while the enrichment items did not significantly increase aggressive behavior among the orangutans, their competitiveness was affected, especially for food enrichment. Food enrichment *may* have indeed taken on a similar meaning that highly prized food items do for wild orangutans. Their resulting competitive behavior for the enrichment could have itself been enriching.

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# Balam Na Cave 4: Implications for Understanding Preclassic Cave Mortuary Practices

SERGIO GARZA, JAMES E. BRADY AND CHRISTIAN CHRISTENSEN

*ABSTRACT: Investigations of several small caves near the community of Poخته, Peten, revealed one that contained a number of small alcoves blocked by walls of unshaped stones. All appear to have been looted in antiquity but the recovery of human bone along with beads of jade and pyrite suggest that the alcoves served as tombs of special individuals. The ceramic assemblage, dominated by waxy wares, indicates that the complex dates to the Late Preclassic. The presence of similar tombs at Naj Tunich points to a previously unnoted Preclassic burial practice that does not appear to continue into the Classic period.*

The presence of human osteological material in caves is one of the few topics in Maya cave archaeology to have received early theoretical discussion. The earliest was George Gordon's (1898) suggestion that the burials in Gordon's Cave #3 at Copan represented evidence of Brinton's Nagualist cult. Oliver Ricketson (1925:394) in his review of ancient Maya burial practices, mentions that caves were not the "usual burying-place." Mary Butler (1934) argued convincingly that the burials in Gordon's Cave, as well as other caves, were not related to the Nagualist cult but does not offer an alternative explanation. Frans Blom (1954) presented a number of examples of cave burials or ossuaries in Chiapas. In his discussion of Maya funerary practices, Alberto Ruz (1968) considers caves as simply another burial context but his few cave examples were never closely examined. J. Eric Thompson (1959, 1975) also mentions the presence of osteological material in caves but saw them as the remains of individuals who might have died while conducting rituals at the site. Systematic attempts to deal with cave osteological material were finally attempted by Brady (1989) and by Ann Scott (1997) in which a range of possible explanations was explored.

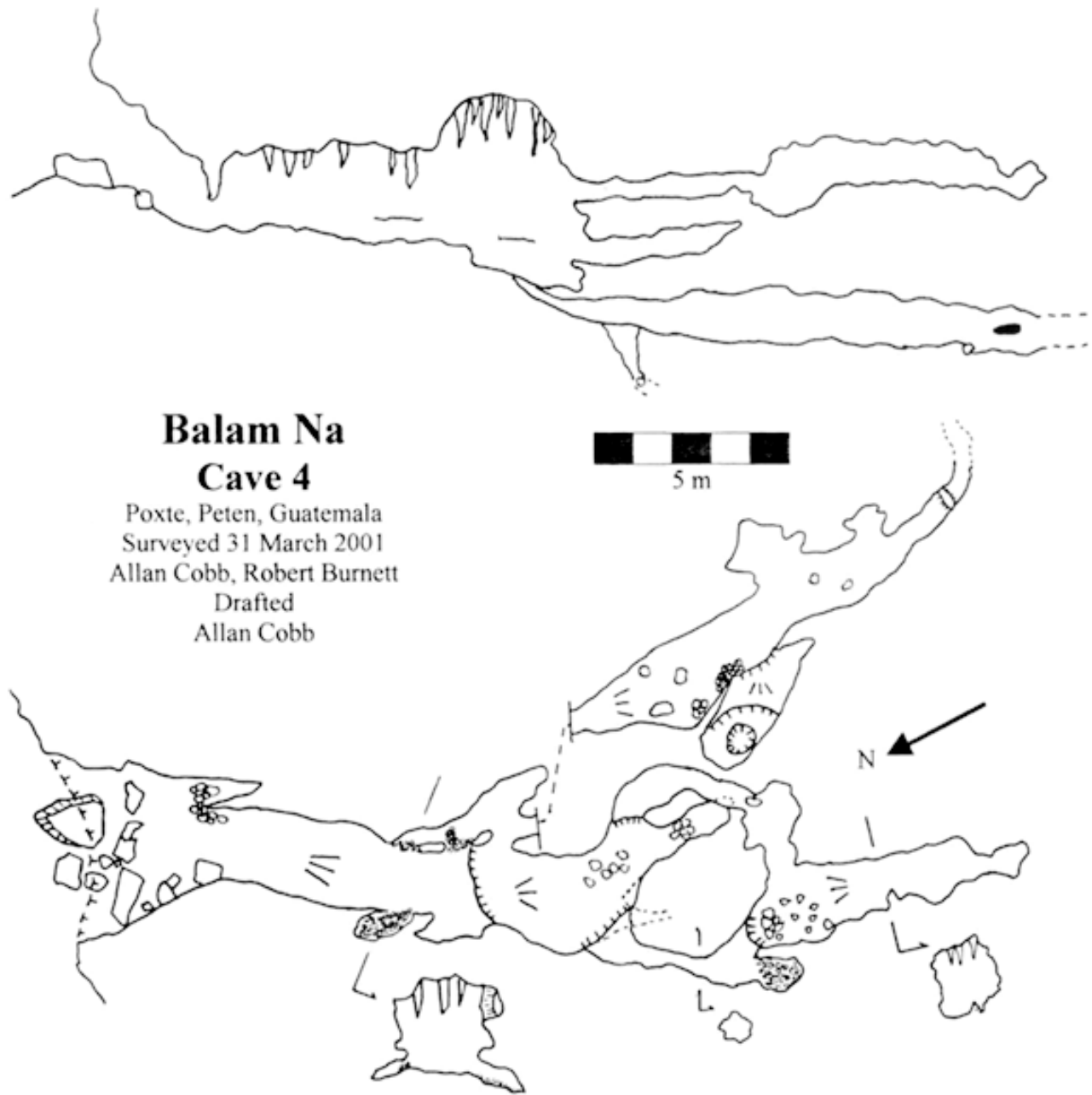
At the time of Brady's synthesis, few indisputable examples of cave interment in the Maya lowlands could be found. Among

those noted were the High Priest's Grave at Chichen Itza (Thompson 1938), the ossuary in Gordon's Cave #3 at Copan (Gordon 1898), the rock lined crypts at San Pablo Cave (Lee and Hayden 1988) and the elaborate, masonry tomb burials at Naj Tunich (Brady 1989). After the work at the Cave of the Glowing Skulls, Scott (1997) argued that the ossuary burial noted at Gordon's Cave is



**FIGURE 1**

Map of Guatemala showing the location of Balam Na and the major cave in the area, Naj Tunich.



**FIGURE 2**  
Plan and Profile views of Balam Na Cave 4.

part of a Honduran burial tradition rather than reflecting lowland Maya patterns. Recent discoveries, however, are radically changing our understanding of Maya burial practices. Excavations by Juan Luis Bonor (1995, Bonor and Martínez Klemm 1995, Bonor and Glassman 1999) at the Caves Branch Rockshelter and work by Keith Prufer in the Maya Mountains appear to document a regular pattern of interment in rockshelters. Prufer notes that San Pablo Cave is actually a rockshelter and so these burials are part of the emerging pattern of rockshelter interment. Thus, the only recognized Maya burials in true caves are the High Priest's Grave and the tomb burials at Naj Tunich. In each case the context is unique and so one would have to conclude that each is an idiosyncratic feature of their particular site rather than reflecting an actual pattern of cave interment.

#### BALAM NA, CAVE 4

In the spring of 2001, a California State University, Los Angeles archaeological project, working under the Atlas Arqueológico de Guatemala, discovered a number of burials in a true cave in southeastern Peten. The site is one of at least seven caves in a small isolated hill called the Balam Na located 16 km northwest of the town of Poptun [Figure 1]. Time permitted the investigation of only four of the caves. The burials were found in the last of these, which was designated Balan Na Cave #4. [Figure 2]

The entrance to Cave 4 is low, only 89 cm high, requiring one to enter on hands and knees. There is also a considerable scatter of large stones at the entrance suggesting that it may have been blocked at one time. A metate, [Figure 3] with a mano set in the bowl, was found buried 26 cm below the surface at the entrance. Eight large sherds representing at least three different Preclassic Waxy Ware vessels were found stacked in a niche to one side of the entrance. The deposit appears to be recent work of looters.

A narrow entrance passage, approximately 5 m long, stretches from the mouth of the cave to a small circular chamber, 2 m in diameter. A number of passages and alcoves radiate off of this chamber. At ground level at the northern end of the chamber is the entrance to a small alcove 74 cm high by 80 cm wide and 230 cm long. The alcove runs parallel to the entrance passage and stone walls appear to have once closed the alcove off from both the entrance passage and the circular chamber. Both of these walls have been pushed over and the soil within the alcove is very disturbed. The soil on the surface contains numerous fragments of human bone suggesting that this space had once served as a tomb. The recovery of a jade bead indicates that the burial may have been richly furnished. All of the ceramic recovered appears to date to the Late Preclassic.



**FIGURE 3**

A metate with the mano set in the bowl was found buried at the entrance to the cave.

Above this alcove is a second smaller alcove with a very restricted entrance, only 77 cm high and 93 cm wide. It appears to have been blocked by a stone wall at one time. The large amount of human bone recovered in the alcove suggests that it once held a burial. In the process of looting, the contents of the burial appear to have been spilt onto two flat shelves in front of the alcove entrance. The upper shelf, 58 x 26 cm, contained several human bones including a finger bone. The lower shelf, 60 x 35 cm, held a good deal of human bone and a jade bead. The soil on these shelves had not been

recently disturbed suggesting that the looting was ancient.

A third set of burials is reached by a low opening at floor level on the eastern side of the circular chamber. A passage slopes downward to a series of lower passages. Most, but not all, of the artifacts were concentrated in the first 5 m of sloping floor. Large quantities of human bone were found but also ceramics, chert, jade, and pyrite beads. Because the bone has been covered by mud over time it does not appear that the looting was recent. At the bottom of the sloping floor, a fragment of long bone was found lying at an angle against the cave wall. The bone was cemented by dripping calcite to the floor where it had fallen, indicating, once again, that the scattering of the bones had occurred some time ago.

Several passages lead off the southern end of the circular chamber. A high passage along the western cave wall contained both human bone and artifacts. The area is badly disturbed but it appears that a body had been placed in the passage at some point.

To summarize the archaeological findings, human skeletal material was recovered from four badly looted alcoves or short passages that, at one time, had been blocked by stone walls. The bone was badly broken and deteriorated so it is not possible to say if only a single individual had been placed in each place without a through analysis. The bone is embedded in a hard clay matrix that covers the original floor. The clay appears to be slowly washing out of the ceiling of the cave where it is interbedded with the limestone. The process appears to be slow enough that it indicates that the looting occurred in antiquity. Since the primary goal of the project was site survey, the amount of soil moved was minimal. Nevertheless, nearly a dozen stone, jade and pyrite beads were recovered suggesting that these burials may have been richly furnished before their looting. All of the ceramic recovered from the cave appears to date to the Late Preclassic.

## DISCUSSION

Interment in alcoves blocked by walls of unshaped stone has not been mentioned in the previous theoretical discussions as a Maya burials type. Nevertheless, Balam Na is not the first site to report this type of architectural feature. At Naj Tunich, several burials placed in natural alcoves and closed off with walls of crude, unshaped stones were described. Brady (1989:354-355) says:

The remaining three structures, if that term can be loosely used to include alcoves which have been blocked by a single wall, have produced no elite goods but seem to date to an earlier period than the formal structures. Thus it is not certain whether the lack of more sophisticated architecture and grave offerings is a reflection of common status or the Preclassic/Protoclassic date of the burials.

The Naj Tunich examples had not been given a great deal of attention because they appeared to be idiosyncratic features at a site that contained a number of unique occurrences. The Balam Na finds are significant in providing a second example of such burials that clarify a number of details at Naj Tunich. Balam Na Cave 4 appears to be a single component, Late Preclassic site. The Late Preclassic/ Protoclassic ceramics recovered from the Naj Tunich structures are, therefore, broadly contemporaneous with those at Balam Na suggesting that the features at Naj Tunich are in fact early.

The early date is significant in suggesting that, prior to the Classic Period, several sites in this area were utilizing natural cave features in much the same way to inter their dead, indicating that we are probably dealing with a formal burial pattern. These early burials appear to be part of an antecedent tradition that was continued and elaborated at Naj Tunich. In the Early Classic, a much larger alcove at Naj Tunich was blocked by a wall of shaped rectangular blocks and stuccoed with a yellow mud "plas-

ter.” Finally, during the Late Classic, elaborate free-standing masonry tombs were built and some were stuccoed with lime plaster. While these elaborate Classic Period masonry structures have no counterparts in known caves, it is now possible to recognize these unique finds as an outgrowth of an established cultural tradition.

Like the Naj Tunich structures, the Balam Na burials had also been looted in antiquity as well as in modern times so the lack of rich burial offerings may reflect nothing more than thorough looting. The quantity of jade, pyrite and stone beads at Balam Na Cave 4 is sufficient to make it clear that they do not represent the pattern often noted with the burial of commoners, that is the placement of single beads in the mouths of the deceased. Rather, the small quantity recovered appears to reflect our very limited sampling of the midden associated with relatively rich grave offerings. The occupants of the tombs, therefore, appear to have held elite status. This is certainly consistent with the tradition as it was elaborated during the Classic Period at Naj Tunich. The burial in Structure 1, dating to the Early Classic, contained jade beads and the remnants of several basal flanged bowls with elaborate, modeled lid handles (Figure 4). The rim of a ceramic vessel bearing a hieroglyphic inscription dealing with high political office was recovered from Structure 2, a Late Classic tomb (Figure 5). Thus there is little doubt



**FIGURE 4**

Elaborate jaguar head lid handle from Naj Tunich Structure 1.

about the high status of the occupants of the later Naj Tunich tombs.



**FIGURE 5**

An inscription referring to royal succession on a Late Classic vessel from Naj Tunich.

The impression of elite status at Balam Na is reinforced when one examines the entire hill as a complex. Hills are important features in Maya sacred landscape (Vogt 1969:375) but this hill would have stood out by virtue of the large number of caves that it possessed. The most important appears to have been Cave 1, which, perhaps not coincidentally, is located highest on the hill. The cave is unusual in that the two entrances allow one to pass through the hill, a feature that seems to have impressed Mesoamerican people. The principal entrance is marked by rock art including a sophisticated jaguar face, a painted *akbal* glyph and some 40 other petroglyphs. Thus, there appears to be a good deal of elaboration of the cave which may reflect its appropriation by a nearby population center. The entrance of Cave 2 is located just below the rear entrance to Cave 1. Immediately inside the entrance, a Late Preclassic plate was found just below the surface. Upon removal, it was found to overlay the bottom of a large inverted red bowl and that was, in turn, covering a small incensario. Human bones had been packed around the vessels in the original hole. Lack of time prevented our excavating the bones. In another place, a cache containing a number of human skulls and another incensario were uncovered but not removed. While the ceramics from Caves 2 and 4 are contemporaneous, the treatment of the human bone is markedly different suggesting that the occupants of each cave held different social positions. Cave 3, located at the base of the

hill, was the smallest and only contained sherds of an unslipped vessel.

In reviewing the archaeology, the hill of Balam Na contains a number of caves that appear to have decidedly individual artifact assemblages and sets of modifications. The most likely explanation is that each cave had a separate function while together forming a single ritual complex. Cave 1 appears to be unusual in the presence of a relatively sophisticated rock art jaguar face and a recognizable hieroglyph. Cave 4, on the other hand, appears to have been the place of interment of the most important members of society.

Another interesting feature of the Balam Na evidence is that the pattern of elite burial in blocked cave alcoves appears, on present evidence, to be temporally restricted to the Late Preclassic. We have outlined the continuity of the tradition at Naj Tunich but it needs to be stressed that the elaborate Late Classic structures at that site have no counterpart at any cave now known from anywhere in the Maya lowlands. Why did the practice cease? Evidence is rapidly accumulating that caves were subject to pillage after military defeats and often the targets of termination rituals. There may have been a stone wall blocking the principal entrance to Cave 1 and the entrance to Cave 2 was blocked at the time of its discovery. We know that the bones of royal ancestors were also targeted. When Naranjo defeated Yaxha in A.D. 710, the bones of a previous ruler were exhumed and scattered about (Martin and Grube 2000:76). It may have been this type of practice led to the discontinuation of the Preclassic burial custom. We would speculate that the interment of ancestors or revered settlement founders within caves simply made them far too vulnerable to desecration by hostile neighbors. During the Classic Period the most important individuals were interred in artificial caves inside of artificial hills, that is, in tombs within pyramids. The bones of revered ancestors were thus afforded greater protection by being deeply buried in the heart of the population center.

## CONCLUSIONS

A review of the cave literature has shown that there has been a long discussion but little agreement over the role of caves in Maya burial practices. When contextual data were examined in detail (Brady 1989, Scott 1997), little good evidence of cave interment in the southern lowlands was found. Instead, many of the examples appeared to be disposal of sacrificial victims. In the five years since Scott's (1997) synthesis, however, the use of rockshelters as ossuaries has become well established. The recent investigations at Balam Na Cave 4 suggest that a second interment pattern may be recognizable. It appears that important individuals were interred in natural cave alcoves, which were then closed off with walls of crude, unshaped stones. The practice appears on present evidence to be temporally restricted to the Late Preclassic. Since both sites where the custom has been identified are in southeastern Peten, it is also possible that this is a regional practice but additional data are needed to resolve this issue. Finally, we have speculated that cave burial may have been discontinued after the Late Preclassic because the remains of revered community founders were too vulnerable to desecration. The tombs at both Naj Tunich and Balam Na Cave 4 appear to have been looted in antiquity. We have noted that the Classic Period practice of burying rulers in tombs inside pyramids represents a symbolic continuation of the Preclassic pattern only the hill and the cave are artificial.

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## ABOUT THE AUTHORS

**Elizabeth Valdovinos** attended American River Community College before transferring to California State University, Sacramento (CSUS). She received her B.A. in Anthropology in 1998 and is currently a graduate student in anthropology at CSUS. She has published an article on orangutan behavior in *The Animal Keeper's Form* (September 2001) and has presented papers at the Sacramento Valley Anthropological Conference (February 2001), California State University Student Research Competition (April 2001) and the Southwestern Anthropology Association meetings (April 2001). She is fluent in Spanish and American Sign Language and earned an Academic Achievement Certificate in ASL from CSUS.

**Sergio Garza** is currently working on B.A. degrees in anthropology and psychology at California State University, Los Angeles. His interests include Mesoamerican cave archaeology, ethnoarchaeology, and multicultural psychology. In the spring of 2001 he participated in the Cal State, L.A. Archaeological Field Project in Guatemala. He is a member of the Phi Kappa Phi, Golden Key, and Phi Theta Kappa honor societies. Additionally, he was elected to Who's Who Among Students in American Universities and Colleges for 2001-2002 and was a recipient of the Sally Casanova Pre-Doctoral Fellowship.

**James E. Brady**, Assistant Professor in the Department of Anthropology, directed the California State University, Los Angeles Archaeological Field Project in Guatemala.

**Christian Christensen**, a Danish explorer, has spent more than 15 years searching the jungles of southeastern Peten for Maya ruins. He was field director on the Cal State L.A. Archaeological Field Project in Guatemala.