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The Great Ladder of Ocosingo: A Twentieth-Century Example of Maya Building Techniques

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In early 1841 John L. Stephens and Frederick Catherwood, while on the second of their two famous journeys in the Maya area, stopped at the settlement of Bolonchen in northern Campeche. During the visit Stephens made a trip to the famous cenote situated south of the village and wrote a detailed account (Stephens 1843:2:137-156). In order to access the water table via the cenote, referred to as Xtacumbi Xunan by the local Yukatek Maya, several imposing ladder-like constructions had been built, and these clearly made a lasting impression on the two travelers. Catherwood drew a plan of the cenote and produced illustrations of the entrance as well as a breathtaking view of a very large ladder leading down to the water table at the base of the cenote (Figure 1).[1] This particular ladder was reached after having descended 20 feet down the cave, where a precipice was encountered. Stephens wrote:

> From the brink on which we stood an enormous ladder, of the rudest possible construction, led to the bottom of the hole. It was between seventy and eighty feet long, and about twelve feet wide, made of the rough trunks of saplings lashed together lengthwise, and supported all the way down by horizontal trunks braced against the face of the precipitous rock. The ladder was double, having two sets or flights of rounds, divided by a middle partition, and the whole fabric was lashed together by withes (1843:2:148, and see plate facing p. 148).

According to Stephens the ladder was insecure, dry, and cracked, and some of the withes were broken. However, as he explains, referring to the nine wells that give the village its name:

> Every year, when the wells in the plaza are about to fail, the ladders are put into a thorough state of repair. A day is appointed by the municipality for closing the wells in the plaza, and repairing to the cueva; and on that day a great village fête is held in the cavern at the foot of this ladder (1843:2:149).

Having made his way down the ladder Stephens found that the descent continued, and no less than eight ladders of varying length and steepness had to be overcome (Figure 2) before finally reaching the cool water some 450 feet below ground. In Catherwood's illustration several men are shown engaged in the heavy and dangerous work of transporting the life-giving water up the ladder in large ceramic jars. Similar ladders elsewhere in northern Yucatan were described half a century later by Henry Mercer at the cave of Actun Chack (eight ladders in total), and Loltun, a site now famous for its rock paintings

[1] In fact, three slightly different versions of the image of the great ladder exist: Catherwood's original sepia watercolor (reproduced in black and white in von Hagen 1968), a lithograph (hand-tinted by Catherwood himself) which appeared in his self-published *Views of Central America, Chiapas, and Yucatán* from 1844, and finally the lithograph prepared by S. H. Gimber for *Incidents of Travel in Yucatan* by John Lloyd Stephens (1843:2:Pl. facing p. 148). Due to the many editions and reprints of Stephens' volumes the latter has become by far the most widely reproduced and distributed version.

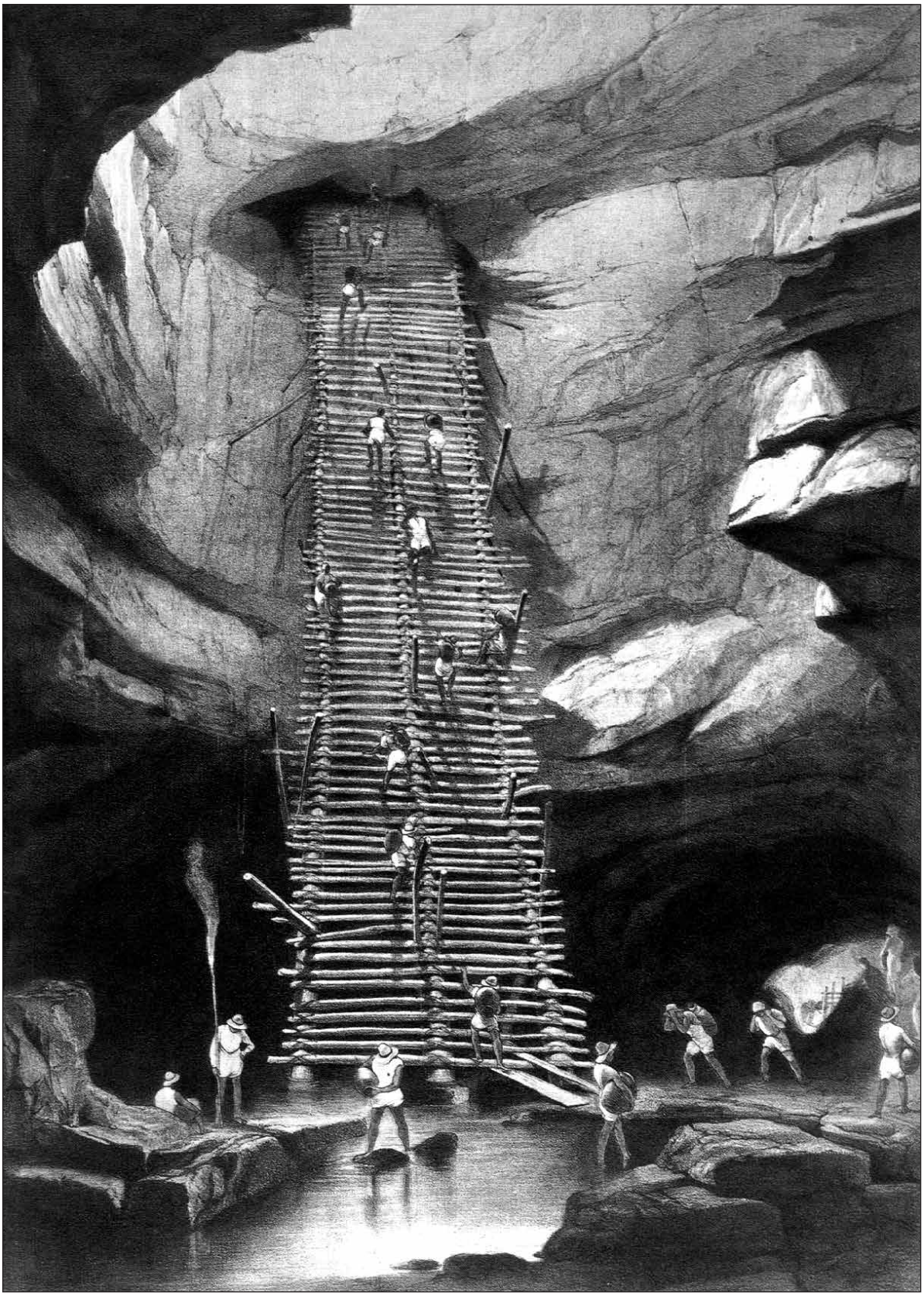

Figure 1. Lithograph from Frederick Catherwood's *Views of Central America, Chiapas, and Yucatán* (Catherwood 1844) showing the largest ladder in the cenote called Xtacumbi Xunan at Bolonchen. Courtesy of George Stuart.

and petroglyphs (Mercer 1975[1896]:91-93, 98-125). According to Mercer the ladder at Loltun was "made by modern Indians, who daily visit the cave to get water, is formed of saplings cut with steel hemp-knives, and tied together with twigs" (Mercer 1975[1896]:125, Fig. 53).

It would thus seem that there was a widespread tradition of constructing such ladders, of varying size, among the Maya of western and northern Yucatan. To judge from their usage and the materials involved, there is little to suggest that they were a recent innovation that can be ascribed to an introduction of European material culture or engineering skills.

The Repair of the Church in Ocosingo

While we have good evidence of ladders being used for the purpose of descending into caves and cenotes from the mid- to late nineteenth century, it is from a later and hitherto neglected source that we find documentation for their use in architectural construction work. In 1928 the Danish-born archaeologist Frans Blom set out on his longest expedition, named the John Geddings Gray Memorial Expedition after the father of the expedition's main sponsor, Mathilda Geddings Gray (Blom 1928a, 1929). Blom, then director of the Middle American Research Institute at Tulane University, was accompanied by Louis Bristow, Webster McBryde, Carlos Basauri, Ciriaco Aguilar, and Gustavo Kanter on the trip of 200 days and 2,400 kms that began in Tapachula on the Pacific coast of Chiapas, moved north through the interior of Chiapas, then passed into Guatemala and the Peten and from there into Quintana Roo, ending in Chichen Itza where the weary expedition members were welcomed by Sylvanus Morley. Sadly Blom never produced a full report on the expedition and its many interesting findings (as was originally his intention), and only a few sporadic publications related to the expedition have appeared. Fortunately Blom kept a field diary, now in the archives of the Middle American Research Institute (M.A.R.I.), and additional documentation from the Geddings Gray expedition is found in *Men, Mules, and Machetes*, a documentary film made by Blom and Maurice Ries in the early 1930s. The film follows the stages of a Tulane expedition from beginning to end, showing the daily routines of packing the mules, crossing rivers in the jungle, and the activities of archaeologists and ethnographers as they encounter archaeological sites and study the living Maya.[2] The film was screened as part of Blom's increasing fund-raising activities in the mid-1930s, a time where he struggled to raise money for a new building for M.A.R.I. (in the shape of the Castillo of Chichen Itza; see Leifer et al. 2002:214-245). Thus Blom had brought along a film camera and with Webster McBryde made several recordings during the Geddings Gray expedition. Among them were footage of Lacandon Maya at the chicle camp of El Capulín (included in *Men, Mules, and Machetes*), and

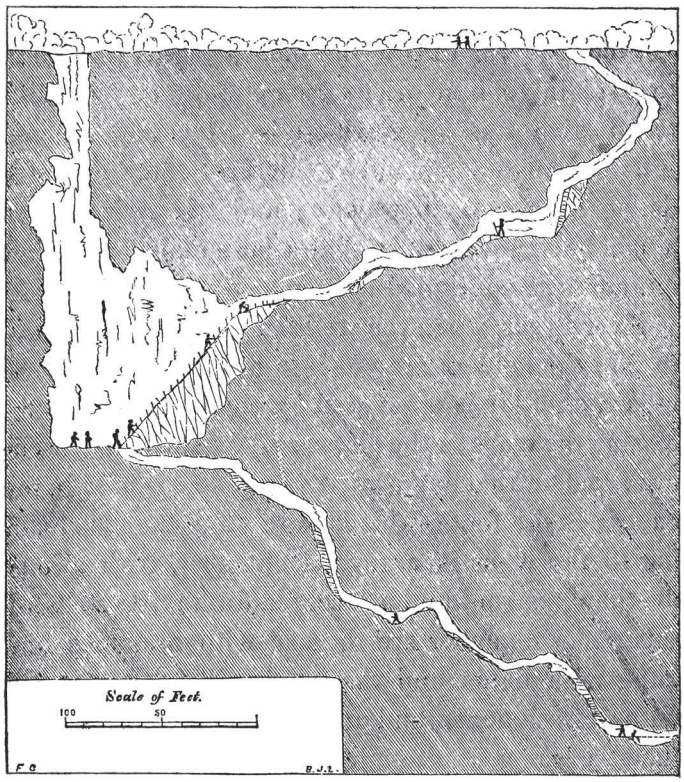

Figure 2: Section drawing by Catherwood of Xtacumbi Xunan with its eight ladders shown (after Stephens 1843:2:150).

what were probably the first moving pictures of Tikal, where Blom climbed Temple I with his camera to take panoramic shots of the temples and roof combs above the canopy (Blom 1928b:255).[3] By comparing Blom's field diary with the film we can occasionally identify the exact date on which he or McBryde made specific recordings.

During the first half of their long journey the expedition arrived at the town of Ocosingo in Chiapas, close to the Maya site of Tonina, which Blom had already visited and described on previous occasions. Blom and his crew stayed in Ocosingo from April 23 to May 2, resting and searching for Maya monuments in the vicinity. According to Blom (1928b:160), Ocosingo was "a dead little place, living on the people who pass through, having a little trade in sugar, and the other local products," and the main reason for the relatively long halt at the quiet town was the fact that they were out of cash and had to wait to receive additional funds from Tulane before being able to continue the expedition. Thus there

[2] The twenty-minute film contains footage from not one but several Tulane expeditions. The film recordings were made by Blom, Webster McBryde, Dan Leyrer, and Douglas Byer. *Men, Mules, and Machetes* was edited by Maurice Ries, another of Blom's employees at M.A.R.I.

[3] The footage from Tikal was not included in the film, and it is uncertain whether the raw footage from the Geddings Gray expedition has survived and is still to be rediscovered at Tulane.

Figure 3: Motion picture frame from Ocosingo showing the ladder in the background while two men are preparing one of the beams that will be used in the renovation of the roof of the church. Frame from *Men, Mules, and Machetes* (courtesy of the Middle American Research Institute, Tulane University).

Figure 4: A large beam is being carried up the ladder; six men carry the beam while a seventh appears to be directing them. Frame from *Men, Mules, and Machetes* (courtesy of the Middle American Research Institute, Tulane University).

was considerable surplus time to observe the daily life of Ocosingo and to film it:

> In Ocosingo the roof of the church fell down a year ago, and […] now the town is spending much energy and talk on the rebuilding of the roof […] Huge beams are being hauled up in front of the church with teams of oxen. We took moving pictures of this. (Blom 1928b:161)

A brief sequence showing the repair of the church roof was included in *Men, Mules, and Machetes*, and it shows seven men in the process of moving a large beam up a substantial ladder-like construction reaching from the ground to the edge of the high sidewalls of the church, thereby providing access to the roof (Figures 3 and 4). Several rather thin poles support the ladder, and while the construction appears somewhat unstable, it was evidently strong enough to carry the weight of seven adults and a heavy wooden beam. Curiously Blom made no further comments on this unusual construction. However, the similarity of the Ocosingo ladder to those from northern Yucatan is evident, and the existence of this particular type of ladder in Chiapas, Campeche, and Yucatan raises the question as to whether this is an original Precolumbian type of ladder or scaffold. Blom's unique footage demonstrates that such ladders were used in construction work and strongly suggests that this is a survival of Precolumbian construction techniques and engineering practices. In other words, if we assume that similar ladders were in use before the time of the Spanish conquest, do we find any evidence that the ancient Maya used them in their construction of monumental architecture and access to caves?

Ladders and Scaffolds in Precolumbian Construction Work

While there is an ever-expanding literature on Maya architecture, its development, regional and temporal styles, as well as its more symbolic significance in ancient Maya society (e.g., Abrams 1998; Andrews 1975:72-79; Houston 1998a; Loten and Pendergast 1984; Stierlin n.d.:131-146), the construction or assembly phase of Maya buildings is a subject on which much less research has been done (Abrams 1994; Helmke 2006:45-48; Inomata et al. 2003; Larios 2003, 2005), and rarely are the use of construction stairs,[4] ramps, ladders, or scaffolds in the construction work mentioned (see however Chase and Chase 2006; Gibbs and Awe 2004; Loten and Pendergast 1984). As simple constructions primarily made of wood, ladders and scaffolds are not likely to have been preserved in the archaeological record, just as we cannot expect them to be represented in the relatively few depictions of the built environment. To my knowledge no images of ladders exist in formal Maya iconography (Houston 1998b) except for the representations of smaller ladders and scaffolds used in ritual sacrifices and accession ceremonies (Taube 1988; Taube et al. 2010:60-69).

However, if we turn to the informal and somewhat cruder representations of the built environment in Maya graffiti (Hutson 2011; Trik and Kampen 1983; Vidal Lorenzo and Muñoz Cosme 2009), we encounter depictions of ladders or scaffolds that are almost identical to

[4] Stanley Loten and David Pendergast (1984:6) describe construction stairs as being "used during construction, presumably to facilitate transport of building materials to upper parts of a structure, but designed to be concealed within the finished structure."

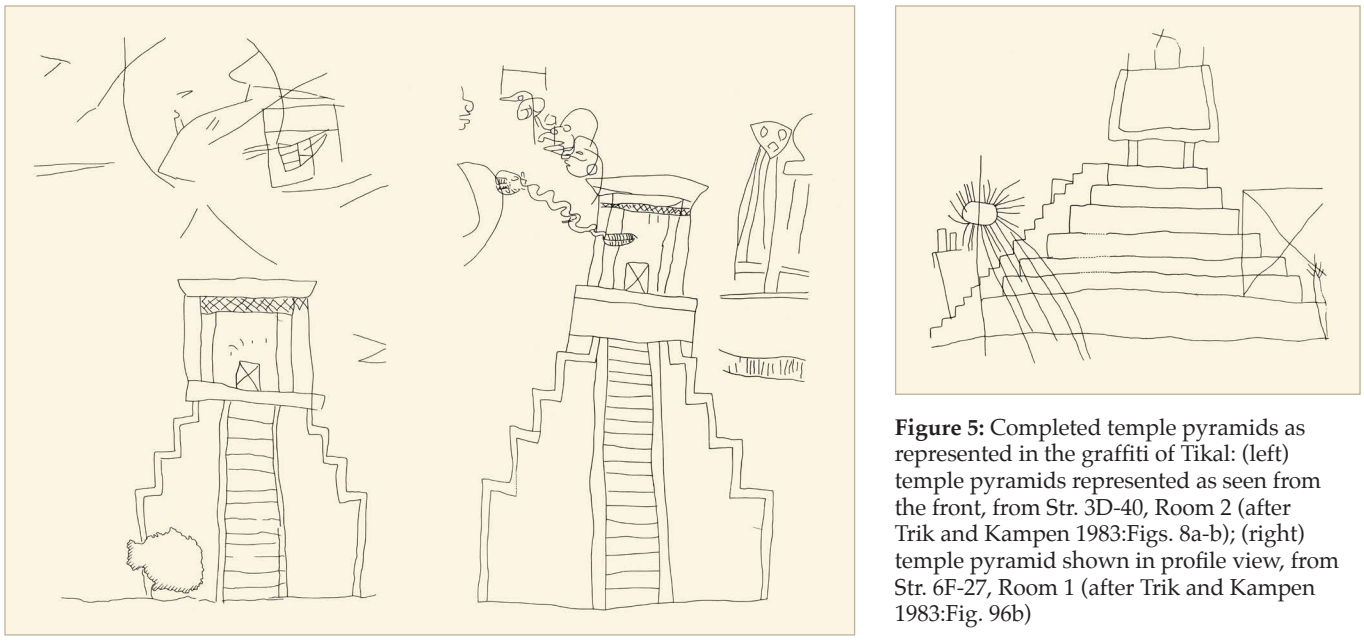

Figure 5: Completed temple pyramids as represented in the graffiti of Tikal: (left) temple pyramids represented as seen from the front, from Str. 3D-40, Room 2 (after Trik and Kampen 1983:Figs. 8a-b); (right) temple pyramid shown in profile view, from Str. 6F-27, Room 1 (after Trik and Kampen 1983:Fig. 96b)

the examples from the nineteenth and twentieth century presented above. Thus the well-documented corpus of graffiti from Tikal contains a number of representations of temple pyramids, and some of these clearly show the completed temples with their imposing central stair, seen either frontally or in profile (Figure 5). In contrast, two highly interesting graffiti from Structures 5D represent temples in profile with a series of ladders connecting the different platforms zigzagging their way towards the summit (Figure 6a-b). Since Maya temples normally do not have permanent masonry stairs arranged in this manner,[5] they may well represent the ladders used by workmen during the construction or repair of the structures. Importantly, we know that wooden ladders were strong enough for construction purposes since the ladder from Ocosingo could carry the weight of seven men and a large beam approximately 4 meters long. We can thus imagine how construction materials were transported on these ladders connecting each of the platforms of the temple structure. An additional sketch of a construction ladder is found in Structure 5C at Tikal (Figure 6c), and once again the similarity to the ladders from Bolonchen and Ocosingo is striking. Perhaps these telling depictions were produced by individuals witnessing the actual construction scene (ongoing ballgames and ritual processions were incised on the walls of other buildings; see for example Trik and Kampen 1983:Figs. 46, 48e-f) and could have been made by a number of palace inhabitants of varying social status with access to the buildings of the central Acropolis.

What is worth emphasizing here is that graffiti as a category of Maya iconography has the potential to provide us with important visual information that rarely, if ever, found its way into the formal and conventionalized themes shown on stelae, lintels, and other public and semi-public monuments. The unfinished temple pyramids with their rickety ladders are perfect examples of this.

With regard to the apparent use of wooden ladders and scaffolds in the construction or renovation phases of temple pyramids and other types of tall buildings, they would have had several advantages compared to earthen ramps and construction stairs. Being light constructions made of readily accessible material they could easily be moved to other areas of the pyramid (possibly after being partly dismantled) or stored for use in future projects. As such they would also have saved both cost and energy compared to other construction techniques.

Unfortunately neither Stephens, nor Mercer, nor Blom provided a local Maya term for the ladders they observed, but the most likely Maya words for ladders of these types are *ehb*, *éeb che'*, or *pepem che'* (or close cognates thereof). Terrence Kaufman reconstructs the proto-Mayan word for "ladder" as **ehb* (Kaufman 2003:942), and the **EHB** logogram for "stair/ladder/step" is encountered several times in Classic Maya inscriptions with reference to both stairs made of stone or masonry and wooden scaffolds or ladders used in accession rituals (Stone and Zender 2011:107; Taube 1988; Taube et al. 2010:60-69). Significantly, the form of the logogram representing a ladder is at times marked by the diagnostic element of the **TE'** sign for "tree/wood," serving to denote that the ladder or scaffolding is made from wood, and in effect also producing the composite

[5] An interesting exception to this is the narrow stairs on the lower platforms of Temple II at Tikal (Christophe Helmke, personal communication 2012).

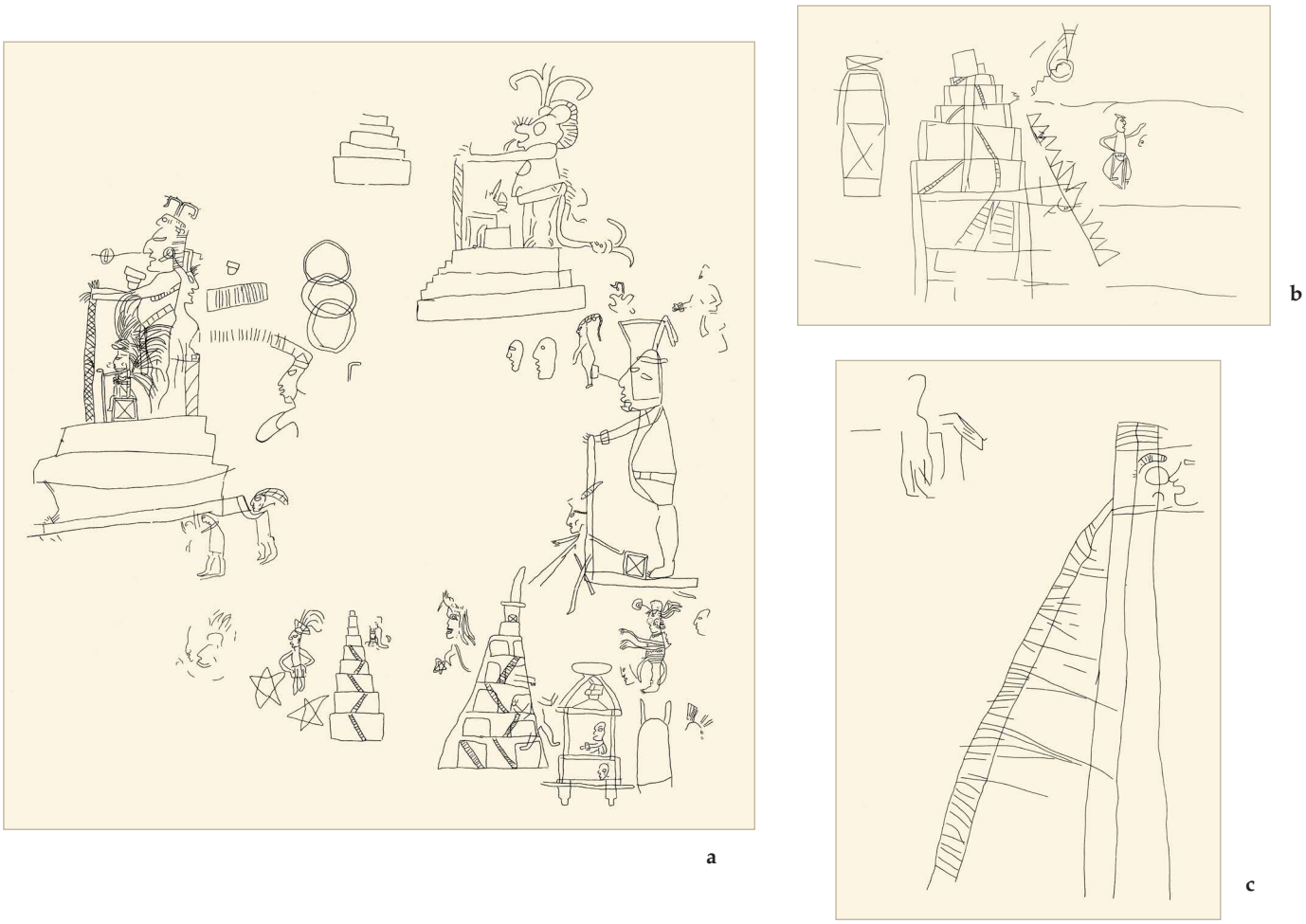

Figure 6: Probable depictions of construction ladders in the graffiti of Tikal: (a-b) series of ladders connect the platforms of a temple pyramid (bottom center and right), from Str. 5D-65, Room 9 and Str. 5D-46, south patio, Room 3B (after Trik and Kampen 1983:Figs. 72 and 51c); (c) large ladder leading to the top of what appears to be a tall structure, from Str. 5C-13, Room 2 (after Trik and Kampen 1983:Fig. 20a).

term *ehb te'* (Figure 7).[6] In addition, in a very revealing case of substitution the name of the dynastic founder of Tikal, Yax Ehb Xook ("First Step Shark"), includes the step logogram **EHB** (Grube and Martin 2000:6; Martin and Grube 2008:26) and undoubtedly served as a reference to his legendary status as the first king to ascend the Tikal throne (Figure 7b) but perhaps also metaphorically to the rise of a particular lineage. In this sense the dynastic successors would constitute the consecutive steps of a dynastic ladder. Stairs inscribed with dynastic history, like the famous Hieroglyphic Stairway of Temple 26 at Copan, may be materialized versions of this concept.

Turning to colonial Maya dictionaries, Yukatekan records provide us with the lexeme *éeb che'* "stair/ladder made of wood/tree" (Bolles 2001), thus constituting a perfect match with the glyphically attested examples from the Classic period. It is likely that the indigenous term used in the northern Yucatan peninsula, including Bolonchen and Loltun, would have been *éeb che'*. Another relevant term encountered in early Yukatek dictionaries is composed of the terms for "butterfly" *pepem* and "wood/tree" *che'* and refers to bridges and scaffolds as well as impermanent platforms and stages used during ceremonies, hunting, and for other purposes, made from wooden poles and branches and lashed together by vines or twigs.[7] The late sixteenth century Yukatek dictionary Calepino de Motul provides us with two additional translations and explanations of the word (see Bolles 2001 for the following and additional entries and references):

> *Pepem che*: andamios y tablados que hazen en los edificios quando los labran sobre que estan los officiales, y los que hazen en los grandes arboles para aguardar la caça, y los que hazen para miran fiestas
>
> *Pepem che*: puente de madera o balsa en que se anda en ella sobre el agua hecha de palos secos y liuianos

[6] A cognate form of this term *jibte'* ("ladder") is encountered in Chontal (Keller and Luciano 1997:134).

[7] In Ch'ol the cognate term *pejpen te'* refers to a specific type of tree with leaves resembling the wings of a butterfly (Aulie and Aulie 1978:93).

Stephen Houston and his co-authors further note that the term is also used for "temporary scaffolds for constructing and plastering buildings" (Houston et al. 2006:256, also making reference to colonial sources). It would thus seem that the term *pepem che'* covers a variety of constructions of wooden poles lashed together with ladders, scaffolds, and bridges among them, and the qualifying noun *pepem* ("butterfly") may have served as a metaphor alluding to the act of rising above the earth and the surroundings. In sum, ladders and scaffolds for construction work, like those I suggest are depicted in the graffiti at Tikal, are likely to have been referred to simply as *ehb*, *ehb te'*, or possibly an earlier cognate form of *pepem che'*.

Conclusion and a Closing Comment

In contrast to the tremendous mass of ancient Maya architecture that has been preserved and which provides us with invaluable information on ancient construction techniques, we still have a limited knowledge of certain aspects of the construction process—that is, *how* the Maya went about raising their imposing temple structures. In this small study I have approached the issue from relatively recent historical and ethnographic sources. A comparison of the descriptions and images of ladders from the nineteenth and twentieth centuries with representations found in ancient Maya graffiti indicates that similar ladders or scaffolds, possibly named *ehb* or *ehb te'*, were among the preferred means of transporting building materials vertically in Precolumbian times. Impermanent wooden constructions like these would have been easy to make, easy to move, reuse, and repair.

If I am correct in my assumption that large construction ladders were in use in the Maya area for more than a millennium, this constitutes a good example of cultural continuity across a considerable time span. Perhaps worth emphasizing is that this is a case of continuity in the know-how and engineering practices associated with construction and access to places that are difficult to reach, which is not immediately related to belief systems, ideology, and religious practices. The latter have been the focus of many scholars over the past years, both those who favor and those who argue against the use of ethnographic analogy in formulating hypotheses about the past. It would seem, however, that the whole dimension of material culture (in particular, objects of daily and more practical use) as documented in the ethnohistorical and ethnographic sources has not yet been fully examined and still holds a great potential to cast further light on the practices of earlier periods. A little more than a decade ago, John Monaghan (2000a:2) pointed to the lack of studies of material culture in the current ethnographic literature (with some notable exceptions of ethnoarchaeological studies undertaken by archaeologists: Deal 1998; Hayden 1987; Hayden and Cannon 1984; Parsons and Parsons 1990; Robles García

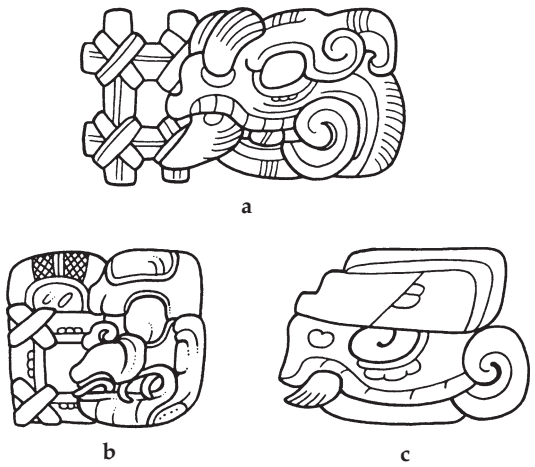

Figure 7: Different variants and occurrences of the logogram **EHB** involved in the name of Tikal's dynastic founder Yax Ehb Xook: (a) early form of the founder's name here written **EHB-XOOK**, wherein the wooden ladder is fastened with rope or vines; Tikal Stela 39; (b) late form of the name, written **YAX-EHB-XOOK**; note the diagnostic element of the **TE'** sign for "tree/wood" (a line with small semicircles attached) representing the wooden elements of a ladder; Tikal Stela 5; (c) substitution set involving the stair form of the logogram **EHB**; note once again the inclusion of the diagnostic **TE'** element; Deletaille Vase. Drawings by Christophe Helmke.

1994:39-41; Smyth 1991; for an early pioneering example see Wauchope 1938[8]), and it could be argued that this is to some degree still a problem that pervades much of Mesoamerican research today. As Jeffrey Parsons and Mary Parsons (1990:367) have noted in their excellent study of maguey utilization in central Mexico: "for the archaeologist there can be no substitute for detailed ethnographic studies that focus directly on the material correlates of mundane activities that have seldom attracted the attention of earlier writers." This is not, however, to say that we should discontinue our efforts to understand and reconstruct ancient Maya mythology and religion—quite the contrary; and by occasionally shifting our focus and interests towards material culture we are in fact likely to come across information that will ultimately throw light on what we normally describe as religious practices and beliefs. While this may not necessarily apply to ladders, many other categories of objects, such as brooms, digging sticks, dried gourd containers, or *manos* and *metates*, undoubtedly had counterparts

[8] In Robert Wauchope's *Modern Maya Houses: A Study of Archaeological Significance*, an ethnographic study was done with the explicit goal of reaching a better understanding of Precolumbian house types and construction techniques: "Many students in the Maya field have pointed out the resemblance between modern Maya houses and the ancient dwellings as we know them from prehistoric frescoes, architectural decorations, and occasional early accounts. It seemed logical, then, that the best approach to an improved interpretation of ancient domiciliary remains could be made by a study of present-day dwellings" (Wauchope 1938:1).

used in religious rituals or played prominent roles in mythology (e.g., Thompson 1930). In a similar vein scholars have pointed out how specific acts related to the dedication of a newly constructed house, which we would describe as impractical or religious, were in a very real sense practical to the Maya involved. The house would not be properly finished or suited for its future inhabitants without the correct dedication rituals (e.g., Monaghan 2000b:30-31; Nielsen 1998; Vogt 1998). Thus we must continuously remind ourselves that our own strict separation of the supernatural from the natural, the sacred from the profane, and the rational from the irrational is not necessarily one always shared with the ancient Maya and the rest of Mesoamerica.

Finally, in terms of preserving traditions and cultural knowledge over generations, the story of the great ladder from Ocosingo is highly remarkable in that the community could only very rarely have been in need of ladders of this extraordinary size (as cenotes are absent in the region and there is no evidence that ladders were used for descending into caves), but still the local knowledge about ladder-making and use was intact and brought into effect as the need arose.

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Toward the Making of a New Map of the Ixcanrio Basin

Thomas G. Garrison
William A. Saturno
Thomas L. Sever
Daniel E. Irwin

The first systematic study of settlement patterns conducted in the Maya area was the Belize Valley Settlement Patterns Project, directed by Gordon Willey in early 1954 (Willey et al. 1965). However, many of the antecedents of that project had their roots in the northeastern Peten of Guatemala. Alfred M. Tozzer commented on various mounds that he observed on muleback during his early work at Nakum (Tozzer 1913), but the greatest advance in the collection of regional settlement data was accomplished by Sylvanus G. Morley. During his expeditions in 1920s and 1930s, sponsored by the Carnegie Institution of Washington, he created site maps and described the sites that he visited as part of his documentation of Maya hieroglyphic inscriptions (Morley 1937-1938). Another Carnegie investigator, Oliver Ricketson, investigated cruciform transects radiating from the center of Uaxactun as an early attempt to research settlement patterns (Ricketson and Ricketson 1937). The settlement data collected by Ricketson was analyzed by Robert Wauchope, who used excavations and ethnographic analogy to argue for the domestic function of mounds on the periphery of the center of Uaxactun (Wauchope 1934, 1938).

After Willey introduced the study of modern settlement patterns in the Maya area, its importance increased in project design, especially in the northeastern Peten. Investigations by William Bullard covered around 250 km of forest trails, and it is estimated that the reconnoitered area covered some 6.25 km^2 (Rice and Puleston 1981:130). Using his research data, Bullard (1960) proposed a hierarchy of three levels of Maya settlement, consisting of house ruins, minor ceremonial centers, and larger ceremonial centers organized in groups, zones, and districts.

The Tikal Project of the University of Pennsylvania made major contributions to settlement pattern studies in the northeastern Peten. The map of Tikal (Carr and Hazzard 1961) showed that the density of Maya settlements was greater than what had been thought previously, a finding of major significance to settlement patterns. However, it was Dennis Puleston's investigations in Tikal (Puleston 1983) and his study between Tikal and Uaxactun that most comprehensively analyzed the density of settlement (Puleston 1974, 1983). This research was part of the Tikal Sustaining Area Project, an extensive study of settlement patterns which was supplemented by excavations carried out by members of the Tikal Project (Fry 1969; Green 1970; Haviland et al. 1968). Puleston's plea for further intersite studies was responded to by Anabel Ford in her Yaxha-Tikal transect (Ford 1981).

In 1981 Wendy Ashmore's study of settlement patterns in the Maya lowlands was published following a School of American Research seminar (Ashmore 1981). In this volume, Rice and Puleston refer to three patterns of settlement in the Peten: "In sum, our needs are many, our region large, and there is much work to be done" (Rice and Puleston 1981:155). In reply to this statement, Richard E. W. Adams introduced a new remote sensing technique to study Maya settlement patterns with the use of radar for mapping (Adams et al. 1981). Adams used radar images to identify systems of canals in the large *bajos* around Maya sites in arguing for intensive agricultural practices that could sustain large populations (Adams 1980; Adams and Jones 1981; Adams et al. 1981). This complemented an already growing interest in Maya agriculture and subsistence, as part of the general patterns of settlement study (Harrison and Turner 1978).

In the northeastern Peten, Quintana and Wurster (2001) have published a catalog of sites and an urban analysis of sites in six river basins including the Ixcanrio. However, the Río Azul Archaeological Project directed by Adams was the only large-scale archaeological project northeast of Uaxactun that operated in the era of the Tikal Project and the San Bartolo Regional Archaeological Project (Adams 1984, 1986, 1987, 1989, 2000). The settlement research of the Río Azul project focused on the sites of Río Azul and El Pedernal (and later Kinal), as well as the Bajo Azúcar and associated cultivation fields and canals (Black 1987; Black and Suhler 1986; Ellis 1989; Orrego 1987; Ponciano 1989). The Río Azul

[1] This article is a translation of Thomas A. Garrison, William A. Saturno, Thomas L. Sever, and Daniel E. Irwin, 2004, Hacia la formación del nuevo mapa de la cuenca Ixcanrio, in *XVII Simposio de Investigaciones Arqueológicas en Guatemala, 2003*, edited by Juan Pedro Laporte, Bárbara Arroyo, Héctor L. Escobedo, Héctor E. Mejía, v. 2, pp. 629-635. Ministerio de Cultura y Deportes; Instituto de Antropología e Historia; Asociación Tikal, Guatemala.

project recorded 27 sites including the three previously mentioned, but these were not sufficiently sampled to be included in the settlement pattern study.

Coincidentally the San Bartolo Regional Archaeological Project has followed in the footsteps of the Río Azul project with its interest in remote sensing and settlement pattern studies. The analysis of settlement patterns in San Bartolo is conducted by William Saturno and Thomas Garrison with the cooperation of Thomas Sever and Daniel Irwin of the National Aeronautics and Space Administration (NASA). Just as Adams collaborated with NASA on his radar mapping, the San Bartolo project has used new technologies of satellite imaging and remote sensing to solve the problems associated with settlement pattern studies in a tropic rainforest environment.

Technology

NASA has developed various remote sensing technologies that have been used in archaeology for several decades (Sever and Irwin 2003). The following is a brief summary of the available technologies, their benefits and disadvantages.

Landsat TM and ETM (Sever and Irwin 2003)

Landsat satellites have been routinely collecting earth-surface data for decades. The Landsat Thematic Mapper, or Landsat TM, and the Enhanced Thematic Mapper, Landsat ETM, have provided data at a multispectral resolution of 30 m (visible bands and near-infrared). The ETM also produces panchromatic data at 15 m to enhance the spatial resolution. Landsat is not high resolution compared to other technologies but it offers some advantages. The repetitive and systematic nature of the Landsat data means that it is possible to access the data from different ground receiving stations, extending over many years from a diachronic perspective.

A good example of this is that Maya causeways are better detected when there is a difference in humidity between the vegetation of the causeway and the surrounding natural vegetation. Hence specific precipitation events can either facilitate or impede the ability to detect Maya causeways or other anthropogenic features in Landsat data. If there were not multiple records of the same area this could lead to errors in the analysis of the imagery.

Another advantage of Landsat is that a single Landsat TM/ETM image is 185 km per side, which is significantly larger than the footprints provided by higher-resolution technologies. Thus drainages and complete *aguadas* can be seen in a single Landsat TM/ETM image. In the case of the Maya area, improved techniques have been utilized with Landsat images in order to distinguish islands in *bajos* in the great seasonal swamps of the northern Peten.

IKONOS (Sever and Irwin 2003)

The high-resolution IKONOS satellite, launched in September 1999, provides panchromatic images at a resolution of one meter, as well as four multispectral bands (visible and near-infrared) at a resolution of four meters. IKONOS covers a nadir swath of 11 km and has been used to collect 700 km^2 of data in selected areas of the Peten. The resolution of IKONOS over Landsat is shocking. In views of the Tikal national park, individual stelae can be seen in IKONOS satellite imagery. The San Bartolo project has conducted one of the first extensive field tests of IKONOS imagery with detailed maps of the San Bartolo-Xultun intersite zone, as well as reconnaissance and field testing of an island in the middle of the large *bajo* northeast of San Bartolo (Garrison 2003). Details of the results of these investigations will be discussed below.

One of the great advantages of IKONOS data is that it makes it possible to locate oneself at an exact point in the landscape using GPS. The ability to locate objects in relation to individual trees, trails, or stream crossings helps clarify the exact distribution of settlement on the terrain. IKONOS images are also useful in indentifying small drainages that do not appear in the lesser resolution of Landsat. This leads to a better understanding of the hydrography of a particular region. It can be supplemented by a detailed classification of vegetation derived from panchromatic and four-band multispectral data, as well as further techniques under study. The great disadvantage of IKONOS is its cost. On the basis of square kilometers, IKONOS data is approximately 1500 times more expensive than Landsat.

STAR-3i (Sever and Irwin 2003)

In the late 1970s and early years of the following decade, Adams and his colleagues collaborated with NASA on a radar map of the Maya area, using SEASAT radar providing images at a resolution of 1:250,000 (Adams et al. 1981). The San Bartolo project will be using NASA's STAR-3i to carry out what was achieved in the 1980s, but at a higher resolution. The radar uses microwave energy in place of visible-light energy to produce an image of the surface of the earth. It can be used at any time of day and can penetrate clouds. STAR-3i is an interferometric synthetic aperture radar system operated by Intermap Technologies that was originally developed by NASA's Jet Propulsion Laboratory and the Environmental Institute of Michigan. Around 2000 km^2 of data have been collected by STAR-3i over the eastern Peten. The data collected over Guatemala include an orthorectified image (ORI) at 2.5 m and a resolution of 10 m (3 m vertical) over a digital elevation model (DEM). The ORI is generated from a point that spreads the information which can be used for visual interpretation. The DEM can be utilized for various applications, such as

topographic mapping, analysis of bodies of water, and analysis from a visual point. DEM is particularly useful for the identification of islands in *bajos* that are ambiguous or cannot be identified in Landsat imagery. DEM can also be used to create three-dimensional models to aid in visualizing terrain.

Quickbird (Sever and Irwin 2003)

Quickbird is a commercial satellite with the highest resolution available to the general public. Quickbird has a panchromatic band of 61 cm and four multispectral bands at a resolution of 2.5 meters. The acquisition of data for the San Bartolo region was delayed by the wars in Iraq and Afghanistan. However, the data have now been collected and will be available for analysis in September 2003. Unfortunately there are no cost estimates for Quickbird at this time, but it safe to say that it will be significantly more expensive than IKONOS.

Geographic Information System (GIS)

Sever and Irwin (2003) have begun to integrate data using ERDAS Imaging GIS Virtual software. The San Bartolo project will integrate the data arrays into an ESRI ArcInfo 8.2 GIS. In order to create models, the data arrays combined with GIS will be useful for restructuring the investigation design to maximize efficiency cost in investigating settlement patterns. With the high resolution of IKONOS and Quickbird and data from STAR-3i, it will be possible to utilize GIS for more than site-projection models, as is common in archaeological applications of GIS, since the located sites are immediately visualized. The catalog of 63 sites recently published by Quintana and Wurster (2001) will also be integrated into GIS in order to create a more complete spatial analysis.

Preliminary Results

The San Bartolo Regional Archaeological Project has conducted significant tests of IKONOS imagery during the 2003 field season (Garrison 2003). The first was the mapping of a *bajo* and peninsula near the San Bartolo-Xultun transect by Garrison and Robert Griffin. The second was the reconnaissance of an island in a *bajo* northeast of San Bartolo by Saturno, Garrison, and Griffin.

Chaj K'ek' Cue

Previous to the 2003 field season Saturno had easily identified San Bartolo and Xultun in an IKONOS image by matching a distinctive yellow signature to the available color images. The most important structures of San Bartolo could be identified. Based on preliminary analysis it was decided that a peninsula between the two sites would be mapped in order to test a probable settlement area identified by Saturno. Garrison, using false-color IKONOS imagery, refined the location, identifying Maya settlement by observing blue inclusions in the yellow areas, indicating the presence of mounds.

The settlements on the peninsula were modest, with 39 mounds and 16 *chultuns* recorded. Additionally, numerous areas of activity and limestone and flint quarries were mapped by the research team. The settlement as a whole was named Chaj K'ek' Cue, which means "Island of Thirst" in Q'eqchi', with reference to the preliminary reconnaissance of the peninsula (Figure 1). Three distinct architectural groups were mapped, each one corresponding perfectly with the blue and yellow settlement markers in the IKONOS image. These correspondences were made by anchoring the site map to the IKONOS image with the GPS points taken during the season, at a scale of 1:5000. The digital IKONOS data has not yet been obtained in order to extract higher resolution results. However, the results of the 1:5000 imagery is sufficient to confirm the usefulness of these images in the identification of Maya settlements.

Isla Oasis

Toward the end of the 2003 season a brief reconnaissance was made by Saturno, Garrison, and Griffin to investigate a settlement on an island in a large *bajo* seen in the IKONOS image northeast of San Bartolo. In the course of the investigation various settlements were located within the *bajo* on an extension of the peninsula on which Chaj K'ek' Cue is situated, including the sites of Las Minas and La Prueba (Figure 1). Maps were not made but numerous GPS coordinates were taken for mound groups, indicated once again by the blue and yellow signatures of ancient sites. Unfortunately, even with the technology available the reconnaissance team was forced to confront the "green hell" of the northeastern Peten, and many of our intentions went unrealized due to sickness, confused guides, and the absence of resources. However, more sites were identified by means of images, and it is safe to say that the 2003 season was successful in field testing of IKONOS satellite imagery, although it will be necessary to undertake more work in following years.

Future Prospects and Conclusions

The San Bartolo project is integrating the use of new remote sensing technologies from NASA in its project design and objectives in the long term. At the regional level the imagery will eventually contribute to the identification of all the sites in the 500 km^2 in the flight path of the IKONOS and Quickbird satellites. This will facilitate the formation of a new map of the Ixcanrio Basin. Locally and in the short term, the investigation of settlements in San Bartolo will be used as a test of the IKONOS and Quickbird data, identifying the strengths and weaknesses of the technology through intensive investigation and extensive excavation.

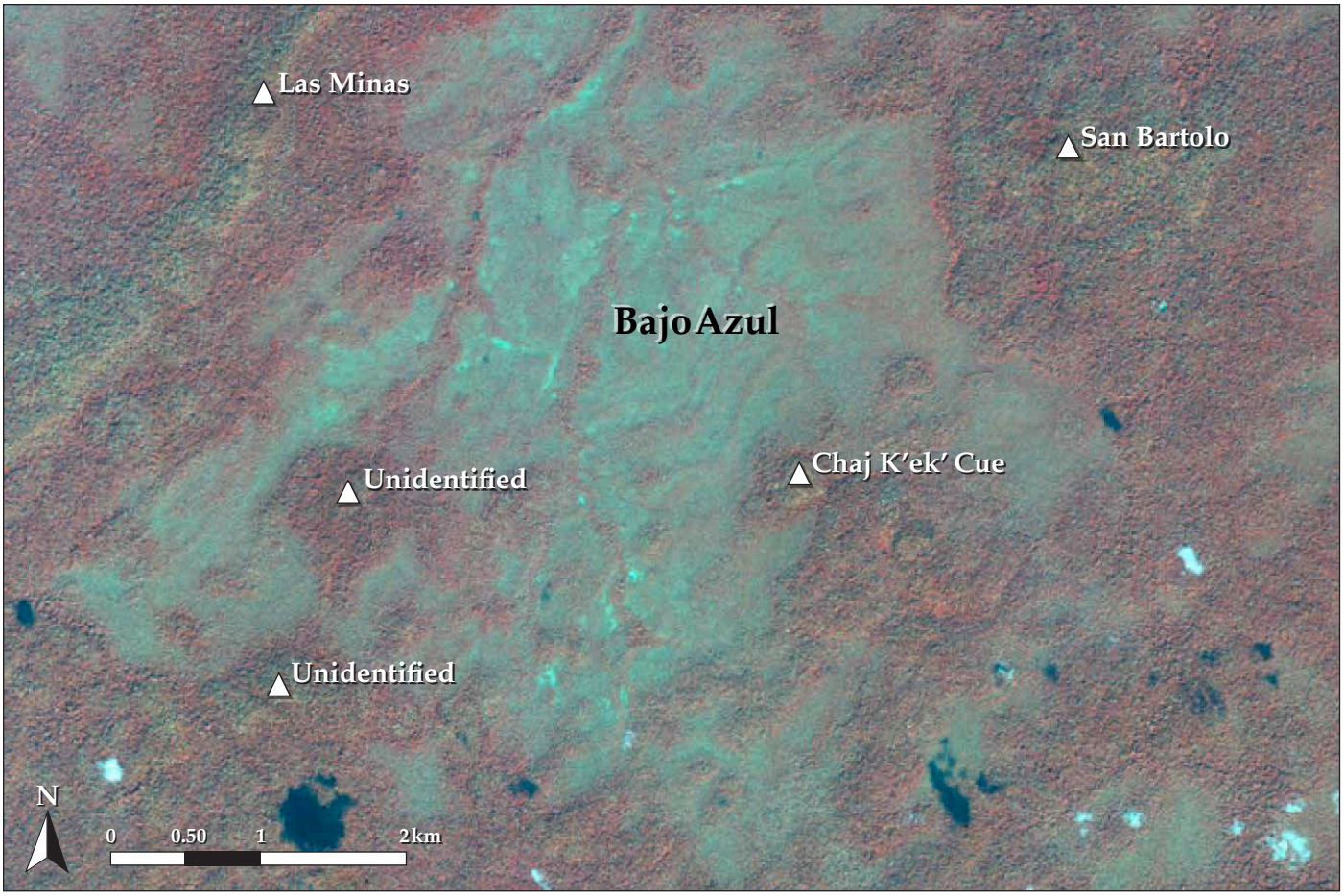

Figure 1. Detail of IKONOS satellite image. Site locations are indicated by a blue-and-yellow signature. Image courtesy of NASA/MSFC. After Garrison et al. 2008:Fig. 2.

The San Bartolo–Xultun intersite area will be used as a sampling universe for this testing. The investigation of an 18 km coverage area will be completed in the next field season, followed by an extensive sampling program to identify chronological sequences in the area covered. The research in San Bartolo will be the first major investigation of an intersite zone between a Classic site and Preclassic one. This is an excellent opportunity for examining social and political changes in the Preclassic to Classic transition. In the analysis, settlement data will be integrated with paleoenvironmental, geological, and hydrological data in a geographic information system in order to generate models of demographic change associated with the decline of San Bartolo and the flourishing of Xultun as a regional power. Later these models will be supplemented by iconographic and epigraphic studies, which will aid in the attainment of a more specific and localized interpretation. Ideally, general social processes detected archaeologically will be associated with specific individuals of the elite population of both sites.

The remote sensing technologies under discussion here are extremely expensive as research tools. The San Bartolo project has benefited from NASA's aid and is fortunate in having been selected to test the IKONOS, STAR-3i, and Quickbird technologies. It is to be hoped that in the process of investigating settlement in San Bartolo and Xultun going forward, and in the larger project of mapping the Ixcanrio Basin, the cost of this high-resolution imagery will be reduced and made more accessible for wider use. In 1981, Adams, Brown, and Culbert recognized that all the problems related to the use of SEASAT remote sensing radar could be traced its resolution. It seems that these obstacles have been overcome by the researchers at NASA, and it is now in the hands of archaeologists to reapply remote sensing to the study of Maya settlement patterns and once again to change the level of detail with which regional studies can be made. It has been a long tradition of Maya settlement studies beginning with the aerial reconnaissance of Alfred Kidder and Charles Lindbergh seventy years ago (Kidder 1930), the use of radar mapping by Adams and his colleagues fifty years later (Adams et al. 1981), and now the application of new remote sensing technologies in San Bartolo and other regions. The results are anxiously awaited.

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Morley's Diary, 1932

Editor's note

A leading archaeologist of his time, Sylvanus Griswold Morley was an Associate of the Carnegie Institution of Washington, the foremost organization excavating archaeological sites in Mexico, Guatemala, and Honduras in the early part of the twentieth century. This diary continues his account of the Carnegie Institution's expedition to Calakmul begun on April 3, 1932. Morley's professional companions were his wife Frances, Karl Ruppert, John Bolles, and Gustav Strömsvik. Some infelicities of grammar and Spanish spelling are preserved.

April 30 – Saturday (cont)

Later we all adjourned to the dining-room where the cake with it's 6 candles was on display. Little Fernandito in whose honor these festivities were being held, blew out the candles and then the children were escorted to the Patio again where there refreshments were served at little tables. The older folks ate in the dining-room. It must have been six-thirty when we finally got away. Even then though the heat was terrific. On our way back to the hotel I stopped at Don Francisco Buenfils' for the third time today and had the good fortune to find him in.

I thanked him for all the services his organization had rendered us and congratulated him on its high state of efficiency. He was pleased as Punch and said he had written his Administrador at Campeche, the Mr. Castilla I had met in the Buenfils' offices there, to place at our disposal every facility of his organization. I told him that precisely that had been done and that our expedition could not have been the success it was had it not been for his transport system, first his White trucks and secondly his mule transport.

I invited him to visit us at Chichen Itzá and he said he would be glad to do so when his two sons return from school at Gulfport, Mississippi, sometime in June.

On this friendly note I again thanked him and took my leave.

From his house we went to the hotel direct and after cleaning up came down to dinner.

After that enormous lunch at the Peon's however, neither of us was hungry so it was a light one. While we were at the table Arthur Rice a Mr. Hobart his assistant, whom I had met several years ago, Joe Rehani, and the new American counsul at Progreso, whose name I did not get, came in.

After they left and just as we were finishing Luis Garcia sent us two bottles of wine as a regalito. These we are taking with us to Chichen Itzá tomorrow.

After paying my restaurant and hotel bills Frances and I went up to Room 31. There was not much packing to be done as we only had one muchila and one bag with us, but when we got into bed we discovered there was not much sleeping to be done either. The heat was furious and stifling and even though we were on the third floor no breeze was to be had. We were in bed before nine.

May 1 – Sunday

A little before 4, perhaps as early as 3:30 a violent storm broke. It began with rain, thunder and lightning and quickly lashed itself to practically hurricane fury.

We had both our windows – facing north – wide open because of the terrific heat, and when it began Frances got up and closed the long screen-like shutters, some eight feet high, but these finally burst open and I had to jump out of bed and hold the shutters to. There was no time to do anything for the other window, nor indeed could Frances have done anything as it was all I could do to hold my pair of shutters closed against the furious blasts of the wind.

The rain poured in and there is no exaggeration when I say there was 2 inches of rain on the floor of the room in no time.

F. thought we might as well get up – it was now 4 and I had left a call for 4:30 – so we dressed by the flash-light which F. had most fortunately saved out. I tried to turn on the electric light but either the current had been turned off down at the Power House or the circuit was broken somewhere for not only was there no light in our room but the whole hotel was in Stygian darkness.

The only thing of ours that got wet were Frances' shoes which were by the other window on the floor. At 4:30 the old night watchman called us but by that time we were nearly dressed and packed. I told him he could begin moving our things down.

Frances walked down stairs in her stocking feet as I was going to have her shoes dried in the kitchen before she put them on. At the bottom of the stairway the first floor was flooded, and we had to build a bridge

of chairs, using three we managed easily to keep ahead of her on which Frances walked across the lobby and one end of the dining-room to the comparative dryness of the inner dining-room.

I had not expected Alberto to show up in such a storm as this nor indeed did he, but in his place, Luis Garcia, the proprietor of the restaurant was up himself and saw to it personally that we got something to eat. As soon as we got down stairs I took Frances' shoes out to the kitchen where the cook put them on the grill literally.

For desayuno we had orange-juice, chocolate and Pan de Pomuch, just enough and it was all good.

While we were eating it Tarsisio came to our table and said Pablo was outside and I told him the baggage would be put in the car at once.

Fernando had said yesterday he was coming down to see us off, but I had urged him not to. He did not show up, but his partner, Johnny Germon did. We really did not need him, but he said he wanted to see that we got our breakfast. We went down to the station in his car which had the curtains down. Pablo took Tarsisio and the baggage down in his car.

The streets were literally awash. The manholes were either choked and non-operative or the water was too much for them to take care of all at once. It was raining when we got to the station but the tempest-like quality of the storm had abated.

We got on our train about 5:20 and John Germon came aboard to chat with us. The Campeche train pulled out from the next track at 5:30 on time and we should have done the same but did not.

It grew lighter and we were still in the station, 5:45. Finally John went out to investigate the cause of the delay and returned reporting that a number of telegraph poles down by the Plancha, or Railroad shops had fallen across the track and it would another half hour before they could be moved.

He stayed on and chatted with us. He and Fernando are dickering with the Camara family to take over the two Camara houses out on the Paseo de Montejo and run them as a hotel. The location is ideal, the surrounding grounds lovely, and together the two houses could be made to accommodate nearly 100 guests i.e. about 60 rooms.

At 6:15, i.e. 45 minutes late the last bell rang for our departure and we slipped out of the station into a gray and very wet world. It seemed as though the bottom had fallen out of the skies in the last 2½ hours, great lakes of standing water everywhere and everything dripping.

When we got out to the Plancha we could see what had held us back. The violence of the wind had torn great pieces of the corrugated iron roofing of the roof of the Plancha off, and had hurled these sections against the telegraph poles, paralleling the building. These in turn had broken and fallen across the track to Vallodolid (our Dzitas track) completely blocking it. All things considered it was very quick work that we had been delayed only three quarters of an hour. All through this section the houses had been damaged and people stood about in wet clothes, very cheerless and forlorn.

We were three quarters of an hour late in leaving Merida and lost another quarter before reaching Dzitas because in some places there was water along the right of way and the train had to proceed very slowly.

At first I thought this rain had been very local, confined to the Merida area, but as we advanced and the signs of a drenching continued everywhere I came to the conclusion that the storm had been general. Indeed we found out later that 5 1/10 inches of rain fell in 3 hours at Chichen Itzá according to our rain gauge.

When we got to Temax we wanted some deer tortillas, but the weather was so threatening, clouds and even rain, that only one vender appeared, a little girl from whom we had never bought before; our nice old lady with the delicious tortillas of yellow maize did not appear. Frances bought some of the tortillas from the girl, but they were cold and tough and I did not eat mine. Someone said the venders had not ventured out because of the storm.

We reached Dzitas at 10:45 instead of 9:45, just one hour late. Betuch met us in the station wagon and we were soon on our way.

I noticed a few local improvements. The street to the Post Office has been graded and it is now possible to drive to the P. O. without breaking a spring.

Several – I counted at least three – new houses had sprung up on the road to Xocenpich just beyond the Glorieta after leaving Dzitas. I asked Betuch where the people had come from and he said: Espita, Vallodolid and even our own Piste. I asked him why Dzitas was attracting so many new residents and he said, "La gente dice que hay mas movimiento en Dzitas que en otros lugares." I suppose it is Chichen Itzá and our operations there which give rise to most of this movimiento.

When we reached Chichen Itzá as it was very nearly lunch time we came right up to the house, where Carlitos, Jaime, Isidro, and Chencho were soon on hand.

Our casa had caught several of the five inches of rainfall. The drain on the roof must have become stopped up, for water had leaked down inside the wall in our bed-room and was all over the floor. This happened several years ago and I was pretty sure when I saw what had taken place that history had repeated itself. But we were home, the house looked oh so comfortable, the bed so inviting, the chairs so easy, my writing table so tantalizing, the bathroom so usable. It was in fact home.