Rocks, Ropes, and Maya Boats; Stone Bollards at Ancient Waterfronts Along the Rio Usumacinta: Yaxchilan, Mexico to El Porvenir, Guatemala

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> "*And so we beat on, boats against the stream, borne ceaselessly into the past*"—F. Scott Fitzgerald

Gathering up the rivers Pasión, Lacantun, and Salinas, the Usumacinta River drains an enormous amphitheater of mountains rising to 11,000 feet. This dramatic topography, combined with high seasonal rainfalls, produces equally dramatic fluctuations in volume. In the Maya Classic Period, the river was always rising or falling, just as it does now, in response to distant rains. Only while loading or unloading could canoes be beached safely. At other times boats had to be securely moored on long lines, and at least partly afloat, so they would neither wash away nor be stranded.

Organized to chart rapids and expand knowledge

Figure 1. Grooves in cluster north of stairs at Yaxchilan, Mexico (photo by Dave Pentecost).

Figure 2. Appearance of natural weathered limestone on shore (photo by John Brown).

of the Maya cultural landscape, the 2004 Usumacinta Navigation Survey found that Maya tied their cargo canoes to rock projections supplied by nature. Over time the mooring ropes wore characteristic grooves in these stone bollards. Though only traces, the grooves illuminate the river's use as an ancient water highway (Figure 1).

Appearance of grooves

The rope grooves are strikingly smooth parabolic arcs, in contrast to irregular points and hollows characterizing the natural limestone. Natural hollows in the rock would have offered ready-made bollards, which rope wear could enlarge and smooth over time. Where a groove overlays erosional pitting, the pits are partially or completely smoothed away inside the groove. The greatest wear is normally on the upstream faces of boulders. Sometimes a slot wraps completely around a rock, and grooves on opposite sides often line up in sets. They often follow the zones of weakness, i.e., bedding planes and joints, but sometimes ignore them and run diagonally across such. Where they are close to the top of a rock knob, the grooves often angle downward on the upstream side, perhaps to prevent the rope from flipping off.

Figure 3. Stone groove incised 12 cm deep at El Porvenir, Guatemala (photo by John Brown).

In cross section grooves are sharply incised, usually with only a little taper. Occasionally there is a smaller notch on the lip of a large one. None show signs of having been intentionally carved. Widths range from 2 cm to 7 cm, with the average width being 4 cm. The deepest groove found at any landing was at Yaxchilan. It measured 15 cm deep. Several at Yaxchilan, Chicozapote Falls, and El Porvenir were also heavily worn.

Rope wear versus erosion

All the grooves seem to be the result of incidental wear from long use. Maya boatmen simply chose projections or holes offered by nature that would hold well, and wrapped their mooring lines around them. The local limestone weathers into complex knobs, spikes and holes, like most tropical limestone (Figure 2). On rocks annually covered by the river, hollows are not smooth, linear, and parabolic, or consistently oriented opposite the current. On the other hand, grooves identified as the result of chafing by ropes are characteristically worn into smooth parabolic slots. Sometimes pairs join to completely encircle a rock. Several rope grooves are so deep and sharply cut that it is hard to imagine their formation by any natural agency (Figure 3). In every case they occur on rocks that provide practical moorings, that is, they would hold a boat well against the normal current.

The parabolic grooves are concentrated around known archaeological sites and—with three exceptions—nowhere else. At Yaxchilan grooves were both densest and most worn along the beach near the Labyrinth and tapered off downriver, as moorings for the city logically would. If they were natural products of erosion, they should not show a strong correlation with Maya sites.

At every locale, grooves stop 1.5 to 2 meters above the water level observed from March 29 to April 3, 2004. This is consistent with upper volume limits for safe river navigation but well below the bankfull stage, the time of maximum erosion. Measured Bankfull Stage varied from 10.2 m at Yaxchilan (on March 29, 2004) to 27.6 m opposite Busilja Falls (on April 3, 2004). At Yaxchilan the river level was approximately 2.4 m above average low water at the time of this survey. The relative level of low water at Busilja Falls could not be accurately determined.

Figure 4. Rope grooves on downstream corner of Rileys Lock #24, Maryland (photo by Ron Canter).

Antiquity of moorings

An obvious concern is whether the moorings, which cannot be dated by direct methods, are ancient—Classic period and earlier—or recent—Colonial and later. A few undoubtedly are still being used: a good mooring is a good mooring. At Yaxchilan, however, contemporary *lancheros* appeared not to be using most of the old moorings, most of which are too far from the modern stairs. The modern mooring stones show no rope wear so far.

No information on rope wear patterns exists in the current archaeological literature, so comparisons were drawn from a nineteenth century American canal and from ancient Roman ports. The closest references, by George Houston and Jennifer Stabler, are to man-made stone bollards at several Roman ports. Correspondence with Houston and Stabler revealed that bollards at the Roman ports of Portus, Aquileia, and Caesarea showed no appreciable wear after 100 years of use. Dr. Houston suggested that ship's hawsers in a calm, tideless harbor would not chafe against the bollards, but ropes holding canoes against a current might work in their grooves.

The C & O Canal in Maryland has a wealth of rope marks from 94 years of towropes being drawn over the coping stones as barges were towed in and out of the locks. Just as river traffic on the Usumacinta would have dropped off during wet season high levels, the canal closed each winter. The wear period is well documented. The first section of the canal opened in November 1830, and all ceased operation after a disastrous flood in 1924. The grooves show only minimal weathering since the canal was abandoned. (Figure 4)

Though the grooves on canal locks were cut by ropes dragged across the rock, rather than by chafing, the wear patterns are strikingly similar to those on the Usumacinta (Figure 5). In cross section the deeper grooves are sharply incised and show just a little taper. Some exhibit secondary notches on the lip, probably formed before the ropes settled into a particular course. All but the shallowest are smooth, without pits. Width of lock grooves varies from 1 to 3 cm, with 2 being average. All were continuous and, with one exception, linear. On Violettes Lock #23, parabolic rope grooves curve vertically over the edge of the lock from a hole that once held a wooden bollard, used to snub barges as the lock was filled or drained.[1]

The 94-year wear period produced grooves in Triassic Seneca sandstone at Pennyfield Lock #22, Violettes Lock #23, and Rileys Lock #24, ranging from 1 to 3 cm deep, with the average 2 cm. Grooves on Mountain Lock #37, Locks # 38, #39, and Irishmans Lock #53 are in Conococheague limestone (Ordovician). Both the sandstone and limestone tested at 3.5 on the Moh Scale of Hardness.[2] The limestone locks were built a few years later and received a bit less traffic. Their grooves are shallower, from 0.5 to 2 cm, with the average 1 cm. All the deeper grooves average 2.5 to 3 cm wide, probably reflecting a common rope diameter.

The limestone of the Lower Boca del Cerro formation, along the shores of the Usumacinta, is equivalent in hardness to the C & O's Conococheague Limestone. If 90 years of wear produced grooves at most 3 cm deep in the former, then a 12 cm notch, such as the one measured at El Porvenir, could reflect 360 years of heavy use.

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[1] In addition to the seven canal locks noted, there were two river locks (Violettes and Shepherdstown) and two aqueducts (Seneca Creek and Antietam Creek) examined. None showed any rope grooves. River boats were maneuvered into the river locks with poles, not ropes. Since there was no change of elevation at aqueducts, the towropes apparently did not drag on the stonework.

[2] The Moh Scale of Hardness is actually a table of relative hardness for ten characteristic minerals. The steps between are not exactly equal.

Figure 5. Rope grooves on block south of stairs at Yaxchilan (photo by Dave Pentecost).

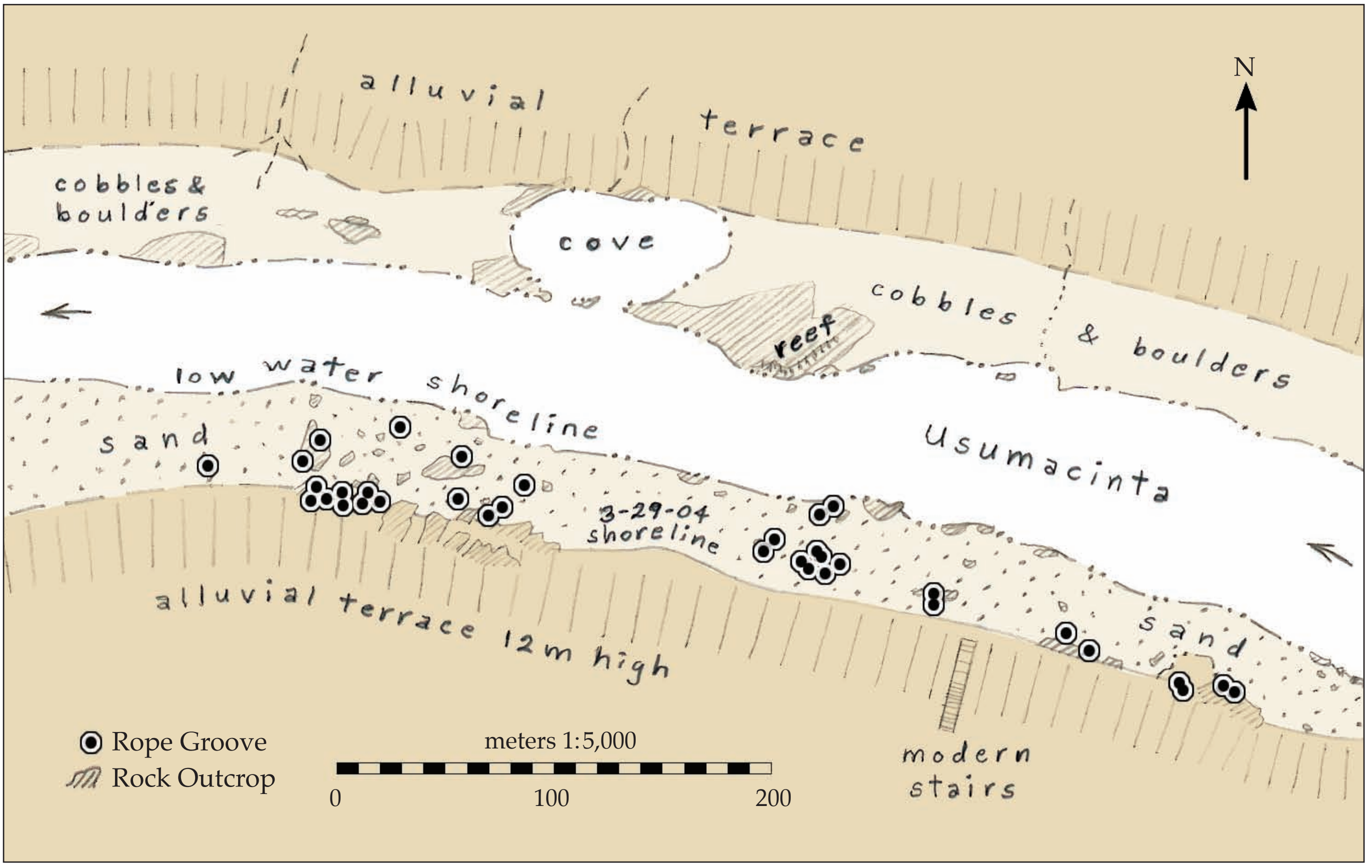

Figure 6. Waterfront at Yaxchilan showing location of stone bollards (map by Ronald L. Canter).

Inferences on ropes

The 2.5 to 3 cm width of rope grooves on the stonework of the C & O Canal fits the average towrope, which could vary from 1.7 to as much as 5 cm in diameter according to C&O Canal Park Historian James Perry (personal communication 2005). The width of grooves on stone bollards along the Usumacinta is more variable, from 2 to 7 cm, with 4 cm the average. One sharply incised groove at El Porvenir had a width of 2 cm.

Maryland canal barges were built to just fit the 27.3 m lock length, but Central American river canoes historically varied from little 3.5 m solo craft (Hammond 1981) to big cargo boats like the 12 m pitpan in which Walker and Caddy ascended the Belize River (Pendergast 1967).[3] The variability of widths of grooves on bollards could reflect many different rope sizes used by Maya boatmen in the Classic to tie up many different boats. There is also the possibility that several canoes were often moored to the same bollard.

[3] Largest of all were the "bongos" encountered by Roberts in Nicaragua and by Stephens on the Rio Palizada in Tabasco. They were 12 m long and about 2 m wide, with a crew of 16 to 22 men, plus the *padrone* (Roberts 1827; Stephens 1841). The bongos drew 1 to 1.5 m, which limited them to the larger rivers.

Maya canoemen almost certainly used cordage made from sisal (*sosquil*), also known as henequen. Sisal is extracted from the leaves of *Agave sisalana*, native to Yucatan. A sisal rope 2 cm in diameter has a breaking strength of 2.87 tonnes, about eighty percent that of Manila "hemp" rope (Timko Ltd n.d.), and half the strength of a modern polypropylene rope. Manila is the strongest of all natural fiber ropes, but the plant is not native to the Americas. Sisal ropes are tough, resilient, and resistant to saltwater, but coarser than manila (Nelson 1998). The length of ropes used by Maya canoemen probably varied from 5 m lines for simple tie-offs to 500 m cordelles for warping.

Other candidates for Maya cordage are cotton, yucca, and lianas. Cotton rope is an unlikely choice. Because of its short fibers, the resulting rope is weak. Ropes of yucca leaf fibers are tedious to make but fairly strong. According to some estimates, they are comparable in strength to hemp and manila cordage. A 1 cm diameter yucca rope reportedly held 0.23 tonnes before breaking (Van Cleve 2004). Lianas, the hanging vines so intertwined with the popular image of jungles, are abundant, free, and have good tensile strength (Slap n.d.). Since lianas become brittle over time, they must be replaced occasionally. For lining canoes up short rapids, the Bush Negroes of South America preferred vines to rope (Davis 1952).

Stone bollards and the waterfront at Yaxchilan

At Yaxchilan, 30 stone bollards have been identified and mapped in a section of shoreline stretching from El Pilar to 240 m downstream of the modern stairs. Many were in a cluster of bedrock outcrops at the downstream end of the modern beach. Many grooves are smoothly incised arcs, but few wrap completely around rocks. Approximately 30 meters north (downstream) of the stairs, five boulders in a cluster, with sets of deep grooves, appeared in the middle of the beach at low water. In addition, Alonso Mendez (personal communication 2005) noted several mooring grooves at El Pilar on stones exposed by a very low water level in 2005.

A silt and sand beach that begins just above the modern stairs and stretches 200 m downstream submerges when the river is 4 m above low water, i.e., at the top of El Pilar. As the river drops, the beach reappears and broadens to a wide strand. The beach is the logical landing, as it would have been in Classic times if the shoreline were not drastically different. Stone bollards at either end and on outcrops within the beach strongly support this conclusion. The area between the most-worn bollards is also the widest part of the beach, about 80 meters below the modern stairs (Figure 6).

Contemporary lancheros moor their craft by driving a post into the sand and tying off to it. This is so simple and logical it seems likely that Classical boatmen would have done the same thing. Most stone bollards may have been moorings for boats waiting their turn at the beach.

A good shore eddy begins about 100 m above the modern stairs (which are 560 m downstream of El Pilar) and runs for 3.2 km downriver, with only a weak countercurrent. The long eddy would have provided an anchorage out of the main current, and enabled boatmen to paddle upriver as easily as down along the inside of the bend. Though stone bollards are most common near the modern landing beach, they were noted farther downstream as well. Their frequency tapers off and stops after 3 kilometers.[4]

The Main Plaza is 23 to 25 m above mean low water. Just downstream from El Pilar on the left bank are remains of an ancient stairway identified by Carolyn Tate (1991). The stairs climbed to the plaza between Structures 6 and 7. The left bank here lacks a large shore eddy and would not have been a practical landing for more than a couple of canoes, but the stairs may have been a special entrance for royalty. On a constantly fluctuating river, broad stairs work rather well as a landing to fit all levels. Any stone bollards found here should show heavy wear from holding canoes against a current.

Possible warping stone at head of Chicozpaote Falls

A natural stone pillar, deeply notched by rope grooves, stands on a point bulging from the Guatemalan shore at the head of Chicozapote Falls, one of only two challenging rapids between Yaxchilan and Piedras Negras.[5] The oblong limestone outcrop runs parallel to the current, rises two meters above the observed water level, and displays fourteen grooves: ten on the upstream face, two on the downstream face, and two near the top that wrap completely around the rock. The two downstream grooves pair up with two of the upstream grooves. One short, near vertical groove even encircled one of the nubs left between other grooves on the upstream face. All of the grooves are deep enough to have supplied a secure bed for a rope, and four grooves on the upstream face are worn approximately 20 cm deep. The deep grooves speak of hard use over a long span of time, probably hundreds years.

Possibilities for the cause of the wear patterns are: a line stretched across the river in a twentieth century log boom, mooring lines from canoes waiting their turn to run the rapid, or a rope anchored for warping up the rapid.

By far the greatest wear is on the upstream face of the pillar, indicating the pull came from downstream. A rope stretched perpendicular to the current should have worn deeper downstream notches than those observed. Floating on the surface, a log boom would have been dangerous, an obstacle for any boat lining up to run the rapids. It would also have blocked the approach to the best landing at the head of the rapid, which is Playa Mojados, in a cove behind the point. It seems unlikely that a rope or boom was ever strung across the river. The depth of wear in the grooves also argues against use in modern logging activities.

The point has no beach or eddy right behind it, and the shore rocks are jagged, so it is a poor spot to disembark. Maya paddlers might have moored to the

[4] Due to safety considerations, the Guatemalan shore was not examined for stone bollards. Being on the outside of the bend, shore eddies on the Guatemalan side are more discontinuous. A reef opposite the lower end of the landing beach forms a shore eddy on the Guatemalan side, so ferrying back and forth is practical here. At low water, the Guatemalan shore eddy becomes a protected cove with a clay shelf at the back, the obvious landing place.

As Joel Skidmore has suggested, boats ferrying across and back would have followed an X pattern. Paddlers work up one bank in the shore eddy before starting across. The canoeists quarter the current, which sweeps the canoe downriver before finishing the crossing. To return, the paddlers climb up the eddy on the opposite shore and ferry back, ending up where they started.

[5] The other hard rapid is Raudal de Piedras Negras, a Class 2-3 rapid 1.5 km upstream of the cove at Piedras Negras.

pillar while waiting a turn at Playa Mojados, which is the best spot to prepare for shooting the rapids. Canoes would have landed only briefly, as boats do today, to scout the route and batten down cargo before a run.

The rock pillar is directly in line with the center of Chicozapote Falls, an ideal location to anchor a rope for warping. Warping is a simple, low-tech method requiring only a long, strong rope, a good tree or boulder for anchor, and a skilled crew. Instead of stumbling along a rugged shore while hauling a canoe with lines, part of the crew carries a long rope to the head of the rapids and ties it to an anchor. They then return to the boat, paying out the cordelle (haul rope) as they go, and get on board. When the crew hauls in the rope, the canoe climbs the rapids, maneuvering past any pour-overs and whirlpools along the shore. It sounds simple, but "[i]t was excessively arduous, slow and hazardous progression, for as we worked out the rapid water swung us around, often tearing us loose from our grip" (Whitney 1912). In spite of the skill and effort required, warping was still faster than portaging all the cargo, and safer than lining from shore.

Formed by a constriction of the river, Chicozapote Falls (called "Raudal Grande de Anaite" in the nineteenth century) is a fairly short rapid—only about 0.5 km from top to tail. Its depth at dry season levels is unknown but probably well over 15 m, so poling upstream is not practical. The steep right (Guatemalan) shore is strewn with large blocks in the shadow of a high limestone cliff, making walking a chore and portaging a heavy dugout impossible. The Mexican side is even more rugged.

Along both shores are whirlpools, hydraulics, and pour-overs to avoid. The hardest spots are at the head of the rapids close to the Mexican shore, and at the foot along the Guatemalan shore. Lining from shore was slow, and sometimes dangerous, as Teobert Maler and Carlos Frey could amply testify (Maler 1901; Shreve 2003). Frey's "patron" knew the river and had his men laboriously pull their unloaded canoe meter by meter upriver along the Guatemalan shore. Teobert Maler tried the Mexican shore and lost his boat at the head of the rapids. Warping up Chicozapote Falls would have avoided all the worst obstacles along either shore.

To lighten a canoe enough to line it from shore, the cargo often has to be unloaded and carried past a rapid, at the cost of much time and energy. This is rarely required when warping. The tradeoff is the time it takes to set up the haul rope. Once in place, however, the rope can be used by all the remaining canoes in a convoy.

This approach is not uncommon worldwide. Where the Potomac River in Maryland twists and churns for 1.5 km through the Seneca Breaks, none other than George Washington scouted the rocks and chutes for the best channel in 1785.

> Washington wanted to keep the navigable channel right in the middle of the wide river. The side channels, he believed, "would probably be frequently choaked with drift wood, Ice, and other rubbish." Obviously there could be no towpath if the channel were so far from the bank, but there could be chains, anchored to rocks, and floated with buoys, with which boatmen could haul themselves up the river. (Achenbach 2004)

Washington was advocating warping up the rapids using fixed chains in place of ropes. The advice was ignored, and a skirting canal built. It frequently clogged with flood debris, and still does.

Where the strength of the crew is not enough to warp up a rapid, they can be aided by men on shore, but only if there is a good rock anchor and a large open space at the head of the rapids. A ring, lashed to the anchor rock, redirects the rope to a flat area with room for the haulers.

In the words of Winston Churchill regarding the chutes of the Second Cataract of the Nile,

> The most formidable, the Bab-el-Kebir, is only thirty-five feet wide [11 m]. The river here takes a plunge of ten feet in seventy yards [47m/km], and drops five feet [1.5 m] at a single bound so that the "Gate" constitutes an obstacle of difficulty and danger which might well have been considered insurmountable.
>
> On the 14th the first gunboat, the Metemma, approached the Cataract. The North Staffordshire Regiment from Gemai, and the 6th and 7th Egyptian Battalions from Kosheh, marched to the "Gate" to draw the vessel bodily up in spite of the current. A strop of wire rope was passed completely round the hull, and to this strong belt the five cables were fastened—two on each side and one at the bow. So steep was the slope of the water that it was found necessary to draw all the fires, and the steamer was thus dependent entirely upon external force.
>
> It was luckily possible to obtain a direct pull, for a crag of black rock rose above the surface of the pool opposite the "Gate." On this a steel block was fixed, and the hawser was led away at right angles until it reached the east bank, where a smooth stretch of sand afforded a convenient place for the hauling parties. Two thousand men were then set to pull at the cables … the passage of each steamer occupied an hour and a half, and required the most strenuous exertions." (Churchill 1902)

A block for the haul line was lashed to a stone in line with the channel. It redirected the warping cable to a flat area, where there was room for thousands of men to pull. This is exactly the same physical situation as at Chicozapote Falls. The broad sands of Playa Mojados

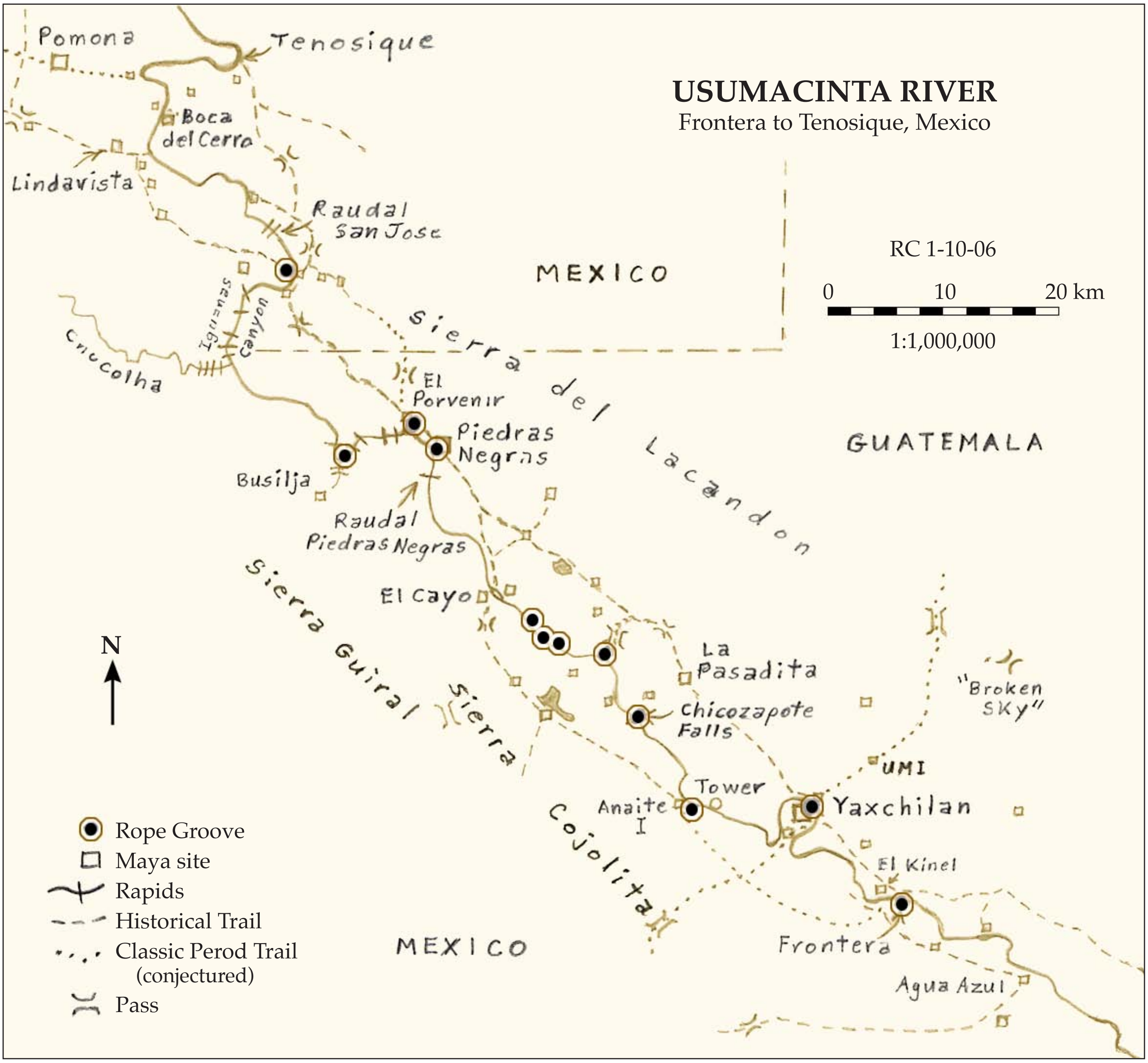

Figure 7. Usumacinta River, Frontera to Tenosique: 1;500,000 (map by Ronald L. Canter).

on the east bank of the Usumacinta River are adjacent to the "warping stone," which is in line with the center channel.

The simplest interpretation that fits all facts is that the stone pillar at the head of Chicozapote Falls was used to anchor a warping rope. Less likely, but still possible, is that it was used to anchor a ring to redirect a haul rope to the beach nearby. It could also have been a mooring for canoes waiting their turn to run the rapids. The uses are not mutually exclusive. If the stone pillar actually were a "warping stone," then it would give a rare glimpse of how Classic Period Maya boatmen might have overcome rapids and avoided a portage.

Other bollards observed between Yaxchilan and El Porvenir

Stone bollards were observed at a number of locations along the river, such as on the left shore above and below the mouth of Arroyo Anaite, close to the Anaite I site (Figure 7). Three km below Piedra de Nemeguey, where a narrow Guatemalan valley opens to the river, a single bollard was found on the right shore. The shore was a wall of broken rock swept by the current, a poor landing. Later in 2004 the Argueta site was discovered close by (Golden et al. 2004).

At a few locales mooring stones were found that do not correlate to known sites. For instance, the shoreline rocks at the mouths of two ravines on the Guatemalan side, respectively 2 and 2.5 km above Split Beach, show good mooring marks. Located 4.5 km above La Playona, Split Beach itself had one well-defined and several possible bollards. Travertine deposits overlay much of the bedrock along shore and may have obscured other bollards.

The shore at the El Chicozapote site was unfortunately not checked due to safety concerns.[6] No bollards were seen near El Chile, which is atop the scarp, not at riverside. Travertine deposition from a series of springs might have covered ones there, or there may have been no landing.

Safety considerations unfortunately prevented a check for bollards at La Playona close to El Cayo. With its immense sand beach and calm cove at the mouth of Arroyo Macabilero, El Cayo has one of the best natural harbors on the Usumacinta.

At Piedras Negras five natural holes in the shoreline rocks below the Roca de Los Sacrificios showed some rope wear, as first noted by Stephen Houston and Hector Escobedo (Stephen Houston, personal communication 2005). The cove is the logical landing for the city but is only 20 meters wide, too small to accommodate much commerce. The city itself occupied the top of the high bluffs from the Preclassic through Late Classic.

Every structure at Piedras Negras, even small platforms and terraces carved into the bluff facing the river, is at least 20 m above dry season river level, which is "9.8 meters below the lowest point on the incised circular band on the Sacrificial Rock" (Satterthwaite et al. 2005). They are just above normal bankfull stage—the 20 m contour—but not above the flood-prone elevation, much like the situation at Yaxchilan.

In high water or flood, canoes would not be safe in a cove scoured by strong currents like the one at Piedras Negras. As Stephen Houston (personal communication 2005) has suggested, the arroyo leading to the Northwest Plaza of Piedras Negras, and the plaza itself during high flood, would have been the nearest calm pool to stash a small fleet of canoes until the river receded. The Northwest Plaza did flood in the 1930s, shortly after the end of the University of Pennsylvania expedition, and Structure E-1 was briefly isolated on a peninsula (Satterthwaite et al. 2005). But a city the size of Piedras Negras must have attracted as much traffic as Yaxchilan, more than a small cove could handle. Where, then, was the main landing?

The El Porvenir waterfront

Less than three kilometers downstream from Piedras Negras is a broad sandy beach running for 70 meters along the midsection of the bay at El Porvenir. East of the beach over 40 stone bollards were found, more than at any other site. One contained a groove 12 cm deep and was clearly not the product of natural erosion. It is one of a cluster of seven grooves in rocks 17 meters north of the main beach. Within the grooves the natural pitting of the limestone has been smoothed away by rope wear. No moorings were more than two meters above river level, except for one small cluster found on the backside of a hill, which becomes an island near shore when the main beach is submerged (Figure 8).[7]

Southwest of the beach there are no bollards. As the rocks and mud increase to the northeast, the number of bollards dwindles away, though rocks 16 m offshore had three. The 2 kph eddy current rotates toward the east side of the cove. Grooves there are opposed to the countercurrent, not downriver flood currents. One example among the rocks and mud had a deeply incised groove 2 cm wide within a larger notch. There were none around a small sand patch in the far corner of the cove. Since the river level was approximately 2.4 m above the normal dry season stage at the time of this survey, there are likely more bollards exposed at lower levels. Interestingly, one outcrop near the beach, and only 13 m southeast of the Cluster of 7, had no mooring marks at all.

The bay stays relatively calm in high water, so the Maya did not need to move a canoe fleet elsewhere (Tammy Ridenour, personal communication 2004). They could just keep retying canoes higher up along the backshore during a rising flood. The modern CONAP ranger station is only slightly above bankfull stage and well within the flood prone elevation.

The depth of wear and the number of bollards at El Porvenir indicate that its bay was one of the great ports of the Maya. The best natural harbor on the river above Boca del Cerro, it is large enough for a fleet, with none of the disadvantages of the steep, narrow landing at Roca de Los Sacrificios. As the last good stopping place for travelers headed to the lowlands, El Porvenir would have been the logical head of a portage around the hardest canyons on the Usumacinta. Both Linton Satterthwaite, in the 1938 report on the Piedras Negras expedition, and Frans Blom, on his 1953 map of

[6] The frequently cited "safety concerns" arose from the Usumacinta Navigation Survey team being robbed at gunpoint at Ojo de Agua 5 km below Tower Station.

[7] Neither Yaxchilan's nor El Porvenir's waterfronts show any signs of intentional improvements: docks, quays, or retaining walls. The frequent changes of water level would make such constructions pointless. Along the Usumacinta River, the Maya seem to have had the same approach as the Romans, i.e., spare every expense: "... a great deal of Roman trade was coastal, carried out by small ships which loaded and unloaded at ports with minimal facilities or no facilities at all (G. Houston 1998)."

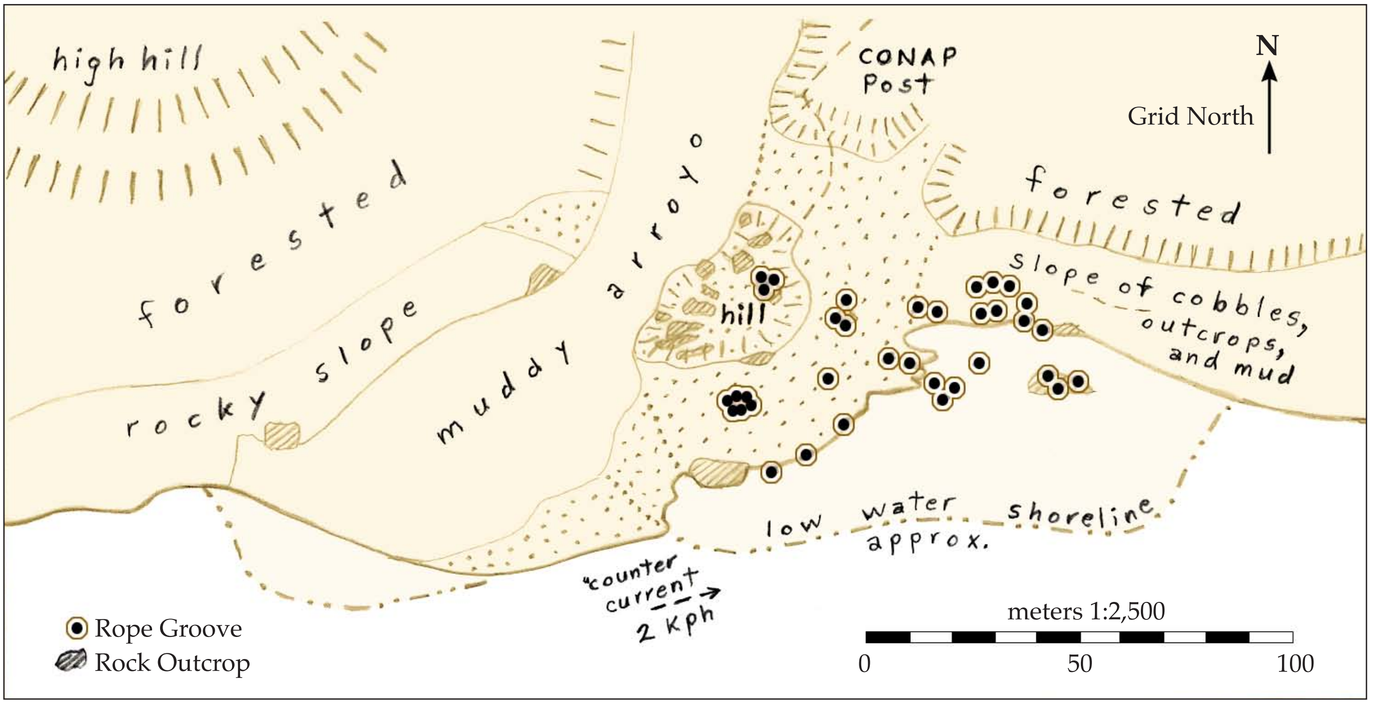

Figure 8. El Porvenir waterfront showing 40 bollards (map by Ronald L. Canter).

the Selva Lacandona, identified the foot of navigation on the upper Usumacinta as El Porvenir. Continuing downstream would have committed canoes to running "Cola del Diablo Canyon" and Iguanas Canyon, both replete with rapids.[8]

The El Porvenir site, with its single plaza and several outlying mounds, lies less than one km northwest of the river. Though modest in size, its active life spanned the Preclassic to Late Classic Periods, and it is the first spot above flood prone elevation along the modern valley trail north to F. I. Madero, which cuts right through the ancient plaza and probably reflects a more ancient trail. House mounds, extending unbroken between El Porvenir and Piedras Negras, show that El Porvenir is a satellite of Piedras Negras, and the likely port for that great metropolis.

The bay at El Porvenir has more bollards, more heavily worn, than any other site along the river. It is hard to imagine Late Postclassic traffic by local Lacandon canoes and vestigial trading expeditions from the coast creating so many deeply worn grooves. In the nineteenth and early twentieth centuries, the *bogadores* of the *monterias* were forbidden to run below Desempeño/El Cayo, so bollards at El Porvenir would have been little used at that time. This suggests the Classic and Preclassic, when Yaxchilan and Piedras Negras dominated the corridor to the coast, as the only time period when enough use occurred to create the grooves observed at El Porvenir.[9]

Conclusions

Humble as they are, rope grooves on natural stone bollards are the most tangible record of canoe traffic on the great highway of the Maya, and help fill in details of ancient navigation in the Usumacinta basin. The large numbers of bollards at Yaxchilan and El Porvenir speak of ports bustling with cargo canoes loading and unloading on the beach, and of others waiting their turn, a scene that would have been at its height during the Classic period. The deeply grooved pillar just above Chicozapote Falls suggests that the Maya neither lined nor portaged there, but rather warped their canoes up the rapid. The river itself shows the mark of nothing except the last rain. It is deep and turbulent, so the bottom may never be surveyed for sunken artifacts. Nevertheless, further exploration will doubtless help expand our knowledge of the watershed's fine-grained cultural texture.

[8] They are the two hardest canyons on the river. "Cola del Diablo Canyon" is a working title taken from the hardest rapid, which is Class 2-3. The canyon begins just downstream of El Porvenir and has nine rapids in 9 km. Three are Class 2 or harder. Iguanas Canyon, between the Rio Chocolha and Raudal El Tumbador, has seven rapids in 7 km. They include three Class 1-2 rapids and two powerful Class 2-3 rapids. In contrast, the 64 km between Yaxchilan and El Porvenir have only two rapids harder than Class 1.

[9] Below El Porvenir, bollards were found at only two other locations: opposite Busilja Falls and at the end of the beach at San Jose Usumacinta. In addition several were later identified upstream at Frontera by the junior author. One had the deepest groove found so far.

Acknowledgments

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