

Paul Harmon tests the capabilities of the local *titora* reed boats. In the past few decades, hollow-hulled wooden boats of European design have largely replaced *titora* reed boats among the Aymara and Uru-Chipaya peoples of the region.



Reed Boats and Experimental Archaeology on lake titicaca

BY ALEXEI VRANICH,
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As much as archaeologists grumble about the scientific merit of Thor Heyerdahl's *Kon Tiki* journey from Peru to Polynesia, one thing is certain: he started a trend. On the positive side, archaeologists began experimenting with a variety of ancient technologies as a means to understand the past. On the negative side, a generation of adventurers decided that the best way to prove their ideas was to build a raft and set it adrift. Since the famous *Kon Tiki*, at least 40 similar expeditions have generated adventure by inventing more and more improbable ways to get from one place to another.

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Boats made of everything from popsicle sticks to wine corks have been spotted all over the world, including a reed boat seen recently cruising down the Amazon River en route to Africa using powerful outboard motors! As we spent three months assembling nearly two million *titora* reeds into a giant bundle 13,000 feet above sea level on the edge of Lake Titicaca in South America, we wondered in which group we belonged, the archaeologists or the adventurers?

TIWANAKU AND ITS MONOLITHS

Around AD 500, one of the small villages along the shores of Lake Titicaca grew into the largest city that had ever existed in the Andes. Huge stones weighing up to 130 tons were brought from distant sources to erect monumental buildings and towering statues spreading over an area of 4-6 km². A huge pyramid of fill and stone, the largest freestanding building ever made in the highlands, rose in the middle of the city. In the mid-16th century, when the first Spanish chronicler of the Andes, Cieza de León, passed through the area, these monuments were already crumbling. He asked the local Aymara Indians if the Inca had built this place. Laughing, they told him it was much older and had been built by a race of giants. They called it *Tapyicala* (“stone in the center”), expressing their belief that this sacred place was the center of the world. Archaeologists call it Tiwanaku.

Alexei Vranich remembers well his first visit to the famed Andean highland ruins of Tiwanaku. As he wandered around the huge stones, his initial impressions echoed almost 400 years’ worth of travelers’ writings on the ruins. Why on earth was there a city 13,000 feet above sea level, far from a navigable river, and lacking any obvious resources? Where was the source of stone for this megalithic city? Even standing on the highest pyramid, all one could see was grass and more grass. Petrographic analysis located the quarry for the abundant red sandstone 10 km away—an incredible distance considering that one of the stones alone weighs over 130 tons. The source of the green andesite stones—the material from which the most elaborate carvings and monoliths were made—is on the Copacabana peninsula, 90 km across Lake Titicaca. How could an ancient civilization—without iron tools, the wheel, draft animals, pulleys, or cranes—transport thousands of tons of igneous rock over such long distances? With barely a handful of trees within hundreds of kilometers, bringing rock across open water seemed impossible.

The answer lay in the vibrant local Aymara Indian communities surrounding Lake Titicaca’s shores and that still make small boats not from wood, but from a lakeshore reed known as *titora*. Typically 2-7 meters long and a third as wide, these



Lake Titicaca sits in a huge geological depression 13,000 feet above sea level in the Andes. Its surface area is 8,563 km², making it slightly smaller than the Mediterranean island of Cyprus. The most substantial body of fresh water in South America, it straddles the border between Bolivia and Peru.

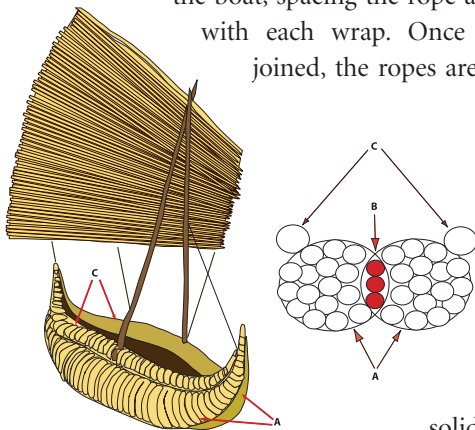
small boats would not be able to sustain the weight of even a small monolith at Tiwanaku. However, in the late 19th century Ephraim Squier noted that boats made of *titora* reeds were large enough to support as many as 60 people. Approximately 4 tons, this is equivalent to the weight of many of Tiwanaku’s smaller monoliths. Several decades later, Hiram Bingham, the discoverer of Machu Picchu, described a reed boat that supported the weight of a plowman and his ox-team, and as recently as the 1970s, reed boats capable of carrying 20 people were still used on Peru’s Ramis River—the largest river entering Lake Titicaca. Could *titora* reed boats like these have been used to move Tiwanaku’s large stones?

We decided to ask the inheritors of this severe landscape to revive an aspect of their ancient technology and do what seemed impossible—to transport a 9-ton stone (the size of Tiwanaku’s most famous monolith) across Lake Titicaca on a boat made of reeds. Using only traditional techniques and locally available materials, we would test the theory by recreating the Tiwanaku boat-building process with a group of leading Aymara *titora* reed boat-building experts.

BUILDING A *TOTORA* REED BOAT

Reed boat manufacturing involves gathering and joining bundles of *totora* reeds and fastening them with rope (traditionally made from dried prairie grass, *ichu*). To build a boat, the reeds must be harvested by cutting them several feet below the water's surface with a scythe or a long pole with a knife tied to the end. Reeds are gathered in bundles (*amaros*) just about big enough for an adult to wrap both arms solidly around them. Once cut, the reeds must be carefully dried in the sun for three to four weeks before they are ready to be used.

Our boat mimicked the small boats in nearly all respects, with the exception of its extraordinary size. The main body, or hull, consists of two large bundles of many long cigar-shaped rolls (*chorizos*) of *totora* that measure roughly 15 m long and 1.5 m in circumference. Placed between these large bundles is the heart bundle, consisting of three *totora* rolls stacked together. To join these bundles, a rope is wrapped around the left bundle and the heart bundle while another rope is alternately wrapped around the right bundle and the heart bundle. This alternating wrapping continues for the entire length of the boat, spacing the rope about 30 cm apart with each wrap. Once the bundles are joined, the ropes are repeatedly tightened over several days. By this point, the heart bundle disappears from view as it is squeezed between the two large bundles, creating a single solid hull. The gunwales, also long cigar-shaped rolls of *totora*, are then connected by rope to the top edges of the hull.



This diagram shows the different elements of the boat as assembled: (A) the hull consisting of two large bundles; (B) joined with ropes to the heart bundle; and (C) the gunwales which border the boat's deck.

From start to finish, it took the extended family of master boat-builder Paulino Esteban 2.5 months to build the boat. On the day of the launch, the boat was 15 m long, 5 m wide, and 2 m high, and it used 3,000 *amaros* of *totora*—approximately 1.8 million reeds! The boat weighed about 12 tons, and it took about 70 people 4 hours to drag it to the shore. Once in the water, it needed only 38 cm of water to float! This draft, and the weight of the boat, would gradually increase as it absorbed more water, making us wonder if it would sink before it became saturated.



Top, *totora* (*Scirpus tatora*) is a reed that grows in the shallow marshy areas of Lake Titicaca. It is used for a variety of practical purposes: woven into roofing for houses, knotted into toy boats and figurines for tourists, fed to cattle to produce milk for cheese, and during times of famine, it is even boiled for food and eaten by the local people. Here, two children use modern nylon rope to tighten the *totora* into bundles. Middle, the boat, constructed of approximately 1.8 million reeds, was built near the shores of Lake Titicaca. Bottom, over the course of 4 hours, 70 people maneuvered the 12-ton, 15 m-long boat into the waters of Lake Titicaca.

GETTING UNDER WAY

When the wind was right and the sails filled, the boat glided across the deep blue waters of the lake to the amazement of local fishermen and gawking tourists. At times when there was no wind, we used oars to propel the boat—a slow and arduous process. Other times, around the shallow shores of the Isla de la Luna—the birthplace of the moon according to Inca and local legend—we pushed with poles while one person pulled with a rope from the shore. Like canal barges, this poling and pulling method easily moved the 12-ton boat with as few as two people.

We sailed toward the town of Copacabana, an important pilgrimage site both today and during the pre-Columbian period. Previous geological analyses had indicated that the green andesite stones of Tiwanaku came from this volcanic peninsula that nearly divides Titicaca into two lakes. Around this peninsula one can also find *piedras cansadas* (“tired stones”) that had been abandoned in the past after having been roughly shaped and dragged to the shore. While our boat was under construction, we located an ideal stone on the outskirts of Copacabana, weighing more than 9 tons and measuring roughly 3 m by 1.3 m by 1 m—about the size of the celebrated Ponce monolith at Tiwanaku. This stone was perched on a steep incline about 20 m above a rocky shoreline. Over several days, 20 Aymara from the Isla del Sol filled the crevasses and troughs of the boulder field below the stone, creating a ramp leading to open water.

Using eucalyptus poles as levers to push and pry the stone and one very thick rope wrapped around it, a group ranging from 25 to 40 people moved the stone to the edge of the water in three days. We now moved the boat into place and anxiously wondered if, with one more push, our experiment would end ingloriously. Would the 9-ton stone tip our boat over, sink it, or even break through the boat? With the help of Bolivia’s navy, we rolled the stone off the ramp and into the boat. Everyone stood quietly for a moment, and then broke into a cheer when the boat held.

THE RETURN JOURNEY

We set out on the return trip after a few minor repairs and adjustments. With the most difficult part of the trip behind us, we had a moment to relax and contemplate the striking landscape of the Andes. As we glided across the lake, we became obsessed with two things. The first was the draft of the boat, which we checked every few hours. We knew that *tatora* would absorb water up to a certain saturation point and then stabilize, as had been the case with Heyerdahl and others’ ocean



Top, under sail, the boat gradually gained weight as its reeds absorbed water. Middle, Caesar Kalisaya stands next to the 9-ton stone—about the size of Tiwanaku’s Ponce monolith—chosen for the trip across the lake. Bottom, the Aymara constructed a ramp to load the 9-ton stone onto the boat.



The stone weighed down the boat during the return journey.

voyages. But this was little comfort while we watched the “ground” beneath our feet sink slowly into freezing waters.

Our other obsession was the wind. We talked constantly about it: when would it change, how long would it last, what would it do tomorrow, and so on. Even when the wind was in our favor, we stared at the sails as if our glare could fill them and push us forward. Such an obsession with the wind was called *amenomania* (literally “wind-madness”) by the Antarctic Shackleton expedition. After abandoning their ship, they had been completely dependent on the wind to move their ice floe toward the open ocean and rescue. As we continuously talked about the wind and its direction and feared we would go insane listening to others talk about it, we came to appreciate their experience.

Our destination was the hamlet of Santa Rosa on the Taraco peninsula, the shore closest to Tiwanaku where archaeological evidence indicates the stones were offloaded. A 13 m wide canal dating from the Colonial period (if not earlier) allowed us to

sail directly into the shelter of its banks. Soon after we arrived, the town’s leaders came to greet us. They were enthusiastic and hospitable. They placed a bridge of eucalyptus between the boat and the bank of the canal, drew ropes around the stone, positioned levers, and lubricated the bridge with water. With about 50 people—men, women, and children—they rolled the stone off the boat and moved it 60 m up the bank in less than an hour with no organization from our team.

TAKING STOCK

We sat on the edge of our boat, which looked quite spacious without the stone, sails, tent, and other equipment. We were thoroughly exhausted from the overnight trip and three months of hard work and stress. Spending our last few moments with the boat, we began to consider exactly what, if anything, we had learned. Was this simply a very challenging and amusing sailing trip, or did we actually do science and enlighten what we know about the past?

The most surprising aspect about this project was how feasible it had been. The raw material, the *titora*, grows in huge and sustainable quantities along the lake’s edge. There were stretches of hard work, but it was accomplished for the most part in a rather tranquil manner by a single Aymara extended family. Large groups of people were needed only for short and rather festive efforts. During the voyage, we were frustrated at times by the currents and winds, and sometimes even afraid. But now that we had the method down and understood more about the lake, we could probably

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With the help of the Bolivian navy, the stone was rolled onto the boat.



Crewmembers Kenji Speilman and Rebekka Rust spent cold nights on the boat.

Catholic Spanish. This document dates to 1571, demonstrating a well-developed sense of geopolitics and European rivalries less than 40 years after the Spanish invasion. Since the agrarian reforms of 1952, the Bolivian republic has gone through many changes of government, in part due to the Aymara getting angry from time to time. Whoever could harness their energy could build an empire, but this energy could turn to violence, or apathy, just as quickly and leave even imperial plans frustrated and half-complete.

Our boat was much more than a purely technological experiment

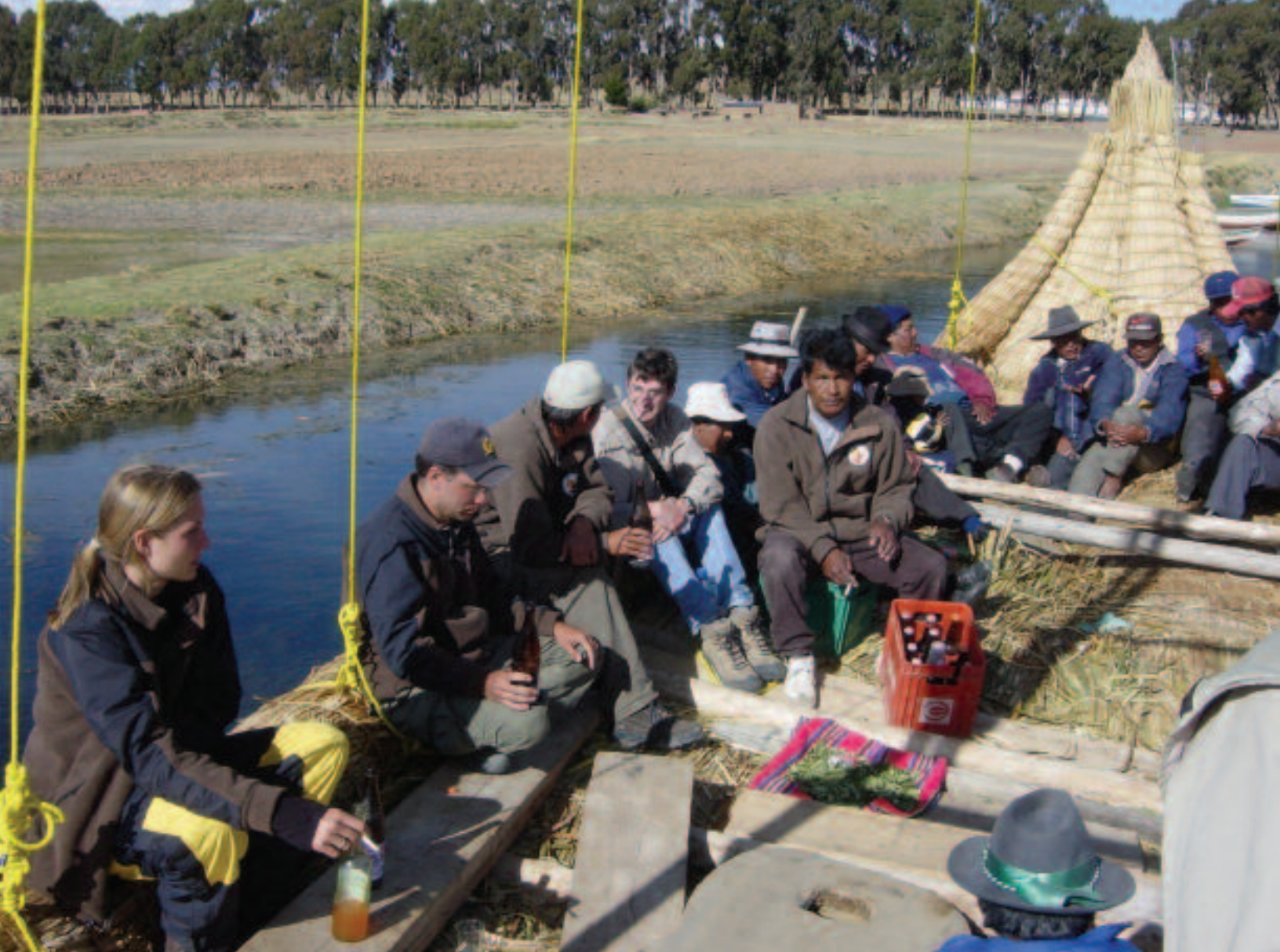
that measured labor expenditure and the buoyancy of *titora*. We recreated a prehistoric object and inserted it into the cultural and social dynamic that most resembled prehistoric conditions. For example, consider Tiwanaku's temples, where closer inspection reveals that their awe-inspiring stonework is often unfinished and made from reused stone taken from earlier buildings. Rather than view the monuments of Tiwanaku as a testament of the power of a mighty few, each stone now speaks to us of the series of decisions, alliances, and rivalries that were negotiated into a single sustained effort.

transport hundreds of tons of stone in a season before the boat gave out. All that would be required is the ability to organize and motivate different groups of people. That aspect, organizing diverse communities across 90 km of shoreline and open water, was our biggest challenge. We initially found this to be very frustrating and an obstacle to our pursuit of science and truth, but this is where the greatest insight from this project lays.

Each community had its own strong identity, personal interests, and deep-seated rivalries. Archaeological and historical evidence suggests that conflict and competition in this region stretch far back into the pre-Columbian period. Fortresses known as *pucarás* dot the hills and mountains of the Titicaca basin and attest to a history of endemic conflict. Historical documents indicate that the Inca were initially defeated when they entered the basin and had to shift to a strategy of gifts and alliances to extend their control. The local inhabitants also lessened the impact of Spanish colonization by shifting the more onerous aspects of taxation onto other groups, and over time grinding the Spanish administration down by constant litigation and legislative appeals. One historical document indicates that the community of Jesus de Machaca, one valley over from Tiwanaku, actually wrote to the Protestant King of England to offer an alliance against the

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From left, Rebekka Rust, Alexei Vranich, Kenji Spielman, and Chris Knutson celebrate the arrival at Santa Rosa with the local Aymara.

The stone was now sitting halfway between the dock and the village of Santa Rosa, surrounded by over a hundred villagers. The mayor of Tiwanaku had come to take the stone to the ruins, as we had originally planned. By the time the mayor arrived, however, the communities of Santa Rosa had organized enough people to petition him to keep the stone here. A long discussion ensued, and in typical Aymara style, every person got to speak his or her mind.

In the end, the villagers of Santa Rosa kept the stone and the boat. In the complex social and political dynamics of the Titicaca basin, the encounter was a success, as the mayor returned to Tiwanaku without the stone, but confident that the favor would be returned by the Santa Rosa community sometime in the future.

We were so engrossed in the negotiations that we completely forgot about one of our crew, Kenji, who did not speak Spanish or Aymara and understood nothing that was said over the last few hours. Looking at the case of beer that had been placed in front of us as a gift from the Santa Rosa community, he said, “So let me get this straight. We just traded our \$6,000, 12-ton boat for a case a beer?”

Alexei was about to give him a summary of the negotiations of the last hour and launch into a lecture on the concept of Andean reciprocity when he realized how tired he was, “Yes, we traded the boat for beer. Would you like one?” 🍺

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Bolivia since 1995. He is currently a Research Associate at the Museum.

PAUL HARMON skipped the totora reed boat across Lake Titicaca. He received his business degree from the University of North Carolina at Charlotte and a master's certificate in project management from The George Washington University.

CHRIS KNUTSON received his B.A. in Anthropology from Penn, where his senior thesis focused on the possibility of using reed boats to transport monoliths to Tiwanaku. He has a master's degree from Cambridge University and plans to combine Ph.D. research with law school and specialize in cultural heritage law.

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For Further Reading

For more details and information about this experimental project, visit their website at <http://www.reedboat.org>.

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After its journey, the boat rests at Santa Rosa.



Above, Alexei Vranich (right) and Paul Harmon (left) leaning against the Ponce monolith at Tiwanaku. To the right, Chris Knutson.

