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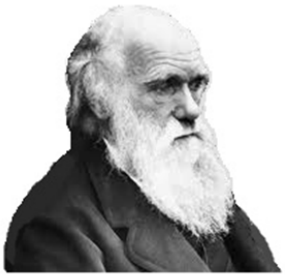

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The importance of the canoe in the lives of indigenous peoples of Brazil

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ABSTRACT

This article examines the construction and use of canoes among Indigenous peoples of Brazil as a form of technical, environmental, and mathematical knowledge grounded in long-term empirical experience. The study is based on ethnographic fieldwork conducted between 2010 and 2025 with communities of the Apiaká, Arara, Bororo, Guarani, Juruna, Kaiowá, Kayabi, Mura, Pankararu, Sateré-Mawé, Tapayuna, Tenharim, and Xavante peoples. Through direct observation, interviews, and documentation of canoe-building practices, the research explores how measurements, proportions, material selection, and spatial reasoning are developed and transmitted outside formal schooling. Drawing on perspectives from ethnomathematics and the indiciary paradigm, the article highlights the role of practical experience, environmental knowledge, and collective memory in shaping these techniques. Canoes are thus approached not only as transportation devices, but as material expressions of Indigenous epistemologies that integrate technical efficiency, cultural meaning, and adaptation to specific riverine landscapes.

***Keywords*:** Indigenous peoples, canoe, ethnic group, material culture, ethnology

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1. INTRODUCTION

Among Indigenous peoples of Brazil, the canoe is far more than a means of river transportation—it is a symbol of cultural continuity and adaptive resilience to the environment. Employed for fishing, gathering, rituals, and intercommunity mobility, the canoe is an integral element of life in territories where rivers serve not only as access routes and sources of sustenance, but also as spiritual landmarks. The wide diversity in forms, sizes, and construction techniques of canoes among Brazil's Indigenous groups reflects the ecological and cultural plurality of the regions these peoples inhabit.

Wooden canoes and boats are indispensable for the mobility of populations living in the Amazon, a region traversed by an extensive and complex network of rivers, *igarapés* (small, narrow waterways typical of the Amazonian floodplains), and lakes. In most areas, terrestrial roads are either nonexistent or impassable. As such, canoes and wooden boats serve as the primary means of transportation for Indigenous, *ribeirinho* (traditional riverine populations characterized by a close dependence on aquatic and forest resources), and extractivist communities—used to reach schools, health posts, local markets, or family members; to access fishing grounds, fruit-collecting areas, timber sources, and hunting sites; and to transport agricultural or artisanal goods to urban centers or regional trading fairs.

Traditional boatbuilding is a cultural hallmark of the Amazon, a region historically shaped by its forested landscapes and riverine arteries. This tradition dates back to the earliest inhabitants of the region—the Indigenous peoples—who were the first naval constructors in Amazonia [1]. Their primary means of transportation were dugout canoes, capable of navigating vast distances by paddle. The inspiration for these vessels came from tree trunks carried downstream by the current. Early Indigenous boats were crafted from a single tree trunk or from bark hulls bound together with forest vines. In many cases, hollowing the trunk involved using axes, machetes, chisels, and adzes, often assisted by controlled burning to soften the wood. Fire, in this context, was not merely a tool but part of a refined technological process through which the wood was gradually consumed and carved.

The dugout hulls constructed by Indigenous and *caboclo* populations (people of mixed Indigenous and European descent, often associated with traditional lifestyles in rural Amazonian settings) continue to be made from a single tree trunk. This technique remains prevalent among Indigenous and riverine communities, primarily because it is cost-effective, practical, and highly maneuverable—qualities that make it ideal for navigating headwaters and dense aquatic vegetation. Such boats are especially favored by fishers and hunters, who rely on agile, lightweight vessels to access remote and ecologically complex areas.

With the arrival of European colonizers in the Amazon [2], new techniques and knowledge related to boat construction were introduced to local populations. These new methods were gradually integrated into Indigenous and regional shipbuilding practices. Over time, boatbuilding in the Amazon underwent several phases of transformation, giving rise to a range of new vessel types. One such example is the *canoa de tábuas* (plank canoe), a handcrafted vessel composed of wooden planks, beams, ribs, nails, screws, caulking fibers, and resins used to seal joints and crevices.

The demand for more advanced vessels was closely tied to the vast territorial scale of the Amazon. A greater number of boats facilitated the transport of agricultural production across Jesuit-controlled regions, supporting both colonization and missionary activities. The shift from solid-trunk construction to plank-built boats represents not only a change in material technique

but also an outcome of Jesuit education programs, which trained Indigenous peoples in naval carpentry and transformed them into master craftsmen in the colonial economy.

Whether built by Indigenous artisans or non-Indigenous naval carpenters, traditional boatbuilding in the Amazon requires meticulous manual skill and a high level of technical expertise. This craftsmanship is embedded in an intricate matrix of traditional ecological knowledge, cultural practice, and empirical innovation. Boats are constructed with materials extracted from the forest, and the knowledge of wood quality, boat design, and construction methods is often transmitted orally through generations, ensuring the preservation of ancestral expertise.

The mathematical knowledge employed by Indigenous boatbuilders can be understood as *ethnomathematics* [3]—a culturally situated body of knowledge developed and transmitted within the professional practice of Indigenous naval carpentry. While rooted in tradition and informality, this knowledge intersects with scientific paradigms and serves as a foundation for the development of formally recognized technical practices. Moreover, it illustrates how Indigenous epistemologies—while distinct in form—contribute meaningfully to broader understandings of science, technology, and sustainable innovation.

2. MATERIALS AND METHODS

This study involved Indigenous peoples from different Brazilian biomes. In the Amazon region, research was conducted with the Apiaká, Arara (Ukarãngmâ), Juruna (Yudjá), Kayabi (Kawaiwete), Tenharim (Kagwahiva), Mura, and Sateré-Mawé peoples. Indigenous groups from the Savannah biome included the Bororo (Boe), Guarani Kaiowá, Guarani Ñandeva, Xavante (A'uwẽ), and Tapayuna (Kajkwakhratxi), while the Pankararu people from the Caatinga biome were also included (Figure 1). The research was conducted with the authorization of the Indigenous communities and the National Indigenous Peoples Foundation (FUNAI), the Brazilian governmental agency responsible for Indigenous affairs.

Interviews were carried out over multiple fieldwork periods: with the Bororo in August 2010; the Apiaká and Kayabi in June 2011; the Pankararu between May and December 2012; the Guarani Kaiowá and Guarani Ñandeva throughout 2014 and 2015; the Kagwahiva in October and November 2014; the Mura and Sateré-Mawé in January and February 2016 and March 2018; the Arara and Juruna in 2019; the Xavante in February 2023; and the Tapayuna in March and April 2025.

Field research was conducted in several Indigenous territories. One of the study regions is the Volta Grande do Xingu (Big Bend of the Xingu River), located in the state of Pará, Brazil, between latitudes 03°23′S and 03°38′S and longitudes 51°33′W and 52°00′W. This approximately 130 km stretch of rapids and braided channels of the Xingu River, a major tributary of the Amazon River, is inhabited by Arara and Juruna peoples.

Research with the Kagwahiva people was conducted in the Tenharim Marmelos Indigenous Land, located in the municipalities of Humaitá and Manicoré, Amazonas State, between latitudes 7°48′S and 8°53′S and longitudes 61°35′W and 62°10′W. Prior to the construction of the Trans-Amazonian Highway, these communities lived together in a single village along the Marmelos River, in the area now crossed by the highway.

The Mura and Sateré-Mawé peoples live in the Rio Urubu Indigenous Territory, located in the municipality of Itacoatiara, Amazonas State, on the left bank of the Amazon River,

between latitudes 02°59′S and 03°12′S and longitudes 58°04′W and 59°48′W. Other study areas include the Apiaká and Kayabi Indigenous territories along the Teles Pires River. The Apiaká territory studied is located in the municipality of Apiacás, Mato Grosso State, between latitudes 07°39′S and 08°32′S and longitudes 57°50′W and 58°21′W. The Kayabi territory spans parts of the municipalities of Jacareacanga (Pará State) and Apiacás (Mato Grosso State), between latitudes 07°54′S and 09°13′S and longitudes 56°39′W and 57°54′W.

Research with the Bororo people was conducted in the Meruri village, located in Mato Grosso State, between latitudes 15°23′S and 15°44′S and longitudes 52°51′W and 53°13′W. The Guarani Kaiowá and Guarani Ñandeva communities studied are located in different villages in Mato Grosso do Sul State, near the BR-163 highway, between latitudes 21°45′S and 23°12′S and longitudes 53°55′W and 54°58′W. The Xavante people studied live in the Ubawawe Indigenous Territory, located in Mato Grosso State, between latitudes 14°23′S and 14°42′S and longitudes 53°20′W and 53°38′W. The Tapayuna villages studied are located within the Xingu Indigenous Territory, Mato Grosso State, along the Xingu River and its tributaries, between latitudes 10°23′S and 11°53′S and longitudes 52°49′W and 53°21′W. The Pankararu Indigenous Territories are located in the interior of Pernambuco State, between latitudes 9°02′S and 9°17′S and longitudes 38°06′W and 38°16′W.

Figure 1. Map of Brazil with the approximate location of the Indigenous lands studied and of some cities as reference.

Data collection was conducted through open and semi-structured interviews [3], allowing for greater flexibility and a more natural dialogue [4]. Indigenous individuals of different genders and age groups, identified by their communities for their knowledge and experience, were interviewed regarding pestle production, raw material availability, and the uses of this artifact.

3. RESULTS AND DISCUSSION

The Indigenous communities studied are characterized by a profound relationship with nature, from which they derive their daily sustenance—whether through traditional agriculture, forest extractivism, hunting, or fishing. Their knowledge systems are deeply tied to the forests and aquatic ecosystems, forming a body of traditional ecological knowledge transmitted across generations. Daily life follows the rhythms of nature, and as riverine communities, practices such as fishing, canoe-building, and navigation are integral to their everyday existence, shaped by the imperatives of survival. Forest resources serve not only as sources of food and income through the sale of forest products, but also provide wood of appropriate quality for the construction of houses, tools, and—most critically—watercraft.

In a region mapped by rivers and *igarapés*, such as the Amazon, where many of these communities are located, boats are essential for sustaining riverine life. Within this context emerges the craft of Indigenous boatbuilding, where master canoe-makers—often referred to as river carpenters—have developed and safeguarded specialized techniques passed down over generations. These artisans possess extensive knowledge of the construction process, including the technical and symbolic properties of the wood, the environmental timing for harvesting, and the tools and methods required to shape canoes adapted to local geographies.

Given the centrality of watercraft, the art of boatbuilding is deeply embedded in the lives of Indigenous peoples. Its value extends far beyond its role as a productive activity through which canoe-makers sustain themselves and their families. Rather, canoe production is woven into the social and economic fabric of community life, fostering interfamily interactions, non-commercial exchanges, and forms of reciprocity that reinforce kinship ties and collective identity.

The empirical knowledge of Brazilian Indigenous peoples in canoe construction represents a deeply rooted technical and cultural expertise, closely connected to their relationship with the territory and the life cycles of the forest. The selection of a suitable tree, for instance, is based not only on physical properties such as density and resistance, but also on ecological, symbolic, and seasonal criteria transmitted orally across generations. Species choice varies according to the intended type of canoe, the navigation environment—igarapés, large rivers, or floodplains—and its planned use, whether for transportation, fishing, or ritual activities.

The use of controlled fire to soften and expand the inner cavity of the canoe, a technique observed among different Indigenous groups, illustrates a detailed understanding of how specific woods respond to heat. This process requires careful timing, constant monitoring, and practical experience, revealing technical knowledge that emerges through repeated interaction with materials rather than formal instruction.

More than a utilitarian skill, canoe-making expresses a holistic knowledge system that integrates environmental observation, spiritual respect for the forest, and the social organization

of community life. It is a dynamic practice in which cosmology, ecology, and manual labor converge in the creation of a culturally embedded artifact.

In this context, Indigenous knowledge is expressed through the sensitive evaluation of wood—its color, scent, sound, and texture—as well as through the recognition of appropriate moments for cutting and hollowing the trunk, guided by variables such as lunar cycles, humidity, and forest vitality. This knowledge is orally transmitted and continually renewed through everyday practice, forming a practical epistemology that is historically accumulated and inseparable from technique, environment, and cosmology.

From this perspective, canoe building is not merely a practical activity, but a domain in which a way of knowing is enacted. Grounded in attention to detail, sensory experience, and cultural memory, these practices exemplify an evidential paradigm in action, demonstrating the intellectual rigor and sophistication of Indigenous technical knowledge, even when it is not formally systematized.

3. 1. Traditional materials and techniques in canoe construction

The tree species selected for canoe building vary according to region and ethnic group, though certain woods are consistently preferred for their lightness, durability, and ease of carving. These woods exhibit properties such as buoyancy, water resistance, and longevity, making them particularly suitable for rivers with varying depths and current strengths.

The Amazon region holds nearly 80% of Brazil's navigable waterways, making it the area with the highest concentration of inland water routes in the Americas. Consequently, for many communities living in this region, boats—particularly those carved from tree trunks—are the primary means of transportation. The Amazon rainforest is home to over 16,000 tree species [6].

Despite this botanical diversity and the widespread need for boats, only about 10 to 15 species are commonly used in boatbuilding in the region. This selectivity is largely due to the intergenerational transmission of knowledge favoring specific species known for their proven performance in this use, as well as the lack of information on the physical and mechanical properties of lesser-known woods. In traditional boatbuilding, characteristics such as hardness, grain, oil content, and resistance to rot are essential in determining suitability for heavy construction.

However, Indigenous knowledge indicates that a greater number of tree species are viable for canoe-making. Our fieldwork revealed the use of 32 different tree species from the Amazon biome in canoe construction among the Indigenous communities visited (see Table 1). Some participants expressed concern about the increasing scarcity of certain tree species essential to boat construction—particularly *Cedrela odorata* (cedar)—likely due to predatory logging by illegal sawmills.

Among Amazonian Indigenous communities, there is a general consensus that *Cedrela odorata* is among the best woods for building boats, though it is often substituted with *Cedrelinga cateniformis* (commonly known as cedrorana). *Goupia glabra* (cupiúba) and *Bagassa guianensis* (tatajuba) were also frequently cited; one Juruna canoe builder referred to tatajuba as "the best wood for a canoe". Other highly valued species include *Mezilaurus itauba* (itaúba), *Manilkara huberi* (maçaranduba), *Dipteryx odorata* (cumaru), and *Hymenolobium petraeum* (angelim-pedra). Itaúba is considered the most useful construction wood—especially for boatbuilding—in the Lower Amazon region.

Itaúba wood is known for its durability, ease of cutting, and ability to be heat-bent. Microscopically, it contains a large number of tyloses, which—along with other anatomical features—render it nearly impermeable. Its high shock resistance makes it particularly suitable for hull construction.

The Indigenous boatbuilders interviewed do not work with architectural plans. Canoes are conceived and built according to the knowledge and experience of each builder. Only one of the builders interviewed—of the Mura ethnicity—reported using rudimentary sketches in a notebook as reference, though these contain no technical specifications. Most others rely entirely on embodied, tacit knowledge, making adjustments as needed throughout the building process.

Considering that many canoe makers have little or no formal education, it becomes relevant to explore how mathematical reasoning is present in their craft. The ways in which these artisans understand, develop, and employ mathematical concepts in the process of canoe construction reveal a form of knowledge rooted in practice. This embedded knowledge is shaped by experience, shared collectively, and applied in specific cultural and environmental contexts, as observed during canoe construction processes in Apiaká, Juruna, and Mura communities.

All cultures develop and apply forms of mathematical reasoning rooted in their lived experiences and material realities. In this sense, knowledge arises from a community's adaptive responses to its environment, including practical mathematics integrated into daily activities. These mathematical ways of knowing are embedded in social contexts and used to solve problems according to locally meaningful logic [3].

There are no shipyards in the villages. Canoes are built near rivers and streams, often right on the forest floor. During fieldwork, we observed this process in several Indigenous communities. Most canoe builders stated that the ideal time for boat construction is during the dry season, from June to December. Boats are removed from the water for maintenance, remaining on land for at least 15 days.

The tools used in boat construction are simple: axe, planer, chainsaw, sandpaper, machete, handsaw, and hammer. Builders usually work alone throughout most of the process, enlisting help only when needed—for instance, in felling trees, sawing them into planks in the forest, and transporting the wood to the village by boat. No safety equipment is used at any stage of the process.

The canoe or boat may be made from a hollowed-out log or built from planks, and is typically powered either by paddle or a 6.5 HP outboard motor. The boats generally measure between 5 and 8 meters in length.

We observed the construction of plank-built canoes in some Indigenous communities. The process begins with selecting a tree in the forest. The tree is felled with an axe or chainsaw, and the wood is rough-sawn into planks on site. These are transported by boat to the village. The base of the canoe (the hull) is sketched onto a plank and cut with a chainsaw, after which the planks are planed. Then, the "ribs" of the canoe are built—supporting arms to which the planks are affixed. The seams are sealed with pitch mixed with burnt motor oil. The full construction process typically takes between 5 and 8 days.

No chemical treatment is applied to the wood. Upon arrival in the village, work begins with planing. Alternatively, the hull may be carved from a single trunk. Once hollowed, the log is placed over a fire to "open" the wood. As one builder explained, some species like cedar

crack under heat and are thus unsuitable. The fire is made using wood scraps left over from the canoe's construction. It also helps shape curves in the wood for finishing and caulking.

The hull is softened over a fire using two logs as rollers: "*You tap it with a hammer, and when the wood gets soft, you work it gently*". Hulls made from a single log are generally between 8 and 14 meters long. The log is placed whole in the fire for 40 minutes to an hour, depending on wind. When pliable, the wood is opened and shaped. Cleaning is done with an *enxó*—a traditional curved blade tool similar to an adze—and the canoe is "ribbed" (internal cross-pieces are added for structural stability). Next come the gunwales and braces, where each rib is matched with two supports. Finally, seats are added, seams caulked, and the vessel is ready.

Hull wood must be dense and impact-resistant, which is why woods such as tatajuba, angelim-pedra, and cupiúba are preferred. Cedar is too brittle: "*It's dry wood; it doesn't have oil, and without oil, it splits*". For this reason, *Copaifera* spp. (copaíba), an oily and highly resistant wood, is greatly valued—especially in areas where the shipworm (*Teredo* spp.), a xylophagous mollusk, is prevalent and can damage boats.

According to one Apiaká builder, the best hull wood is cedrorana (*Cedrelinga cateniformis*), while the best wood for ribs is louro (*Aniba guianensis*), due to its flexibility and durability. For gunwales, cedar is preferred. An elder Apiaká craftsman, who still used an axe to make his boats, remarked that chainsaws have made the process much easier. He insisted that the best plank canoe wood is cedrorana, a view shared by others who noted that this species is still abundant in the forest. Cedar, though excellent, is now rare, and louro is also considered a high-quality wood.

One difference between plank canoes and dugout canoes lies in hull thickness; the rest—ribs, gunwales, and other elements—are similar. Building a small plank canoe is more challenging, particularly when using planks only 1.5 to 2 cm thick, which can split if a nail is placed incorrectly. Indigenous builders explained that a cracked or punctured canoe can be repaired, but if it breaks in half—e.g., upon hitting a rock—it is beyond repair. If a hole appears, they enlarge it into a square, insert a wood patch, and secure it with nails, sealing it with cotton and pitch.

The notion of empirical knowledge, as explored by the Italian historian and philosopher Carlo Ginzburg (particularly in his classic essay *Clues: Roots of an Evidential Paradigm*), applies in a particularly relevant way to the Indigenous knowledge involved in the construction of artifacts such as canoes. Ginzburg argues that, unlike the scientific-experimental paradigm—based on general laws and repeatable verifications—the evidential paradigm is grounded in the interpretation of signs, traces, marks, and symptoms. This type of knowledge develops in contexts where experience, careful observation, and practical inference are fundamental—as is the case for hunters, early physicians, artists, and also traditional artisans.

In a similar way, Indigenous peoples of the Amazon, in crafting canoes, operate with a highly sophisticated form of empirical and evidential knowledge. Among the practical applications of the evidential paradigm in Indigenous canoe-making, we can highlight:

Choosing the right tree

Indigenous canoe-makers not only know how to identify the ideal species for canoe construction, but also perceive subtle signs indicating the quality of the wood—such as the texture of the bark, the sound the tree makes when struck, the presence of fungi or insects, the color of the heartwood, and the location where the tree has grown (terra firme, várzea, or igapó). These signs are not systematized in manuals but are interpreted based on accumulated

experience, often passed down through generations—a form of tacit epistemology, as Ginzburg would describe it.

Timing the cut

The act of cutting the tree is also associated with signs in nature: the phase of the moon, the season, animal behavior, and the moisture content of the wood. This is a kind of context-sensitive knowledge, based on patterns that are difficult to quantify, yet effective in practical terms.

Excavation and curing process

During the excavation of the canoe (particularly those carved from a single log), artisans adjust their technique based on the smell of the wood, the resistance of its fibers to axes or adzes, and the sound the wood produces when struck. These elements act as "clues"—in Ginzburg's terms—that guide the artisan's work based on a network of past experiences.

As with the evidential paradigm, this knowledge is neither theoretical nor systematized. It is embodied: the artisan's body "learns to see" and act upon the material; it is orally transmitted: masters teach apprentices through shared practice and daily coexistence; it is culturally situated: this is not merely a utilitarian technique, but a form of knowledge that is cosmologically rooted (for instance, involving respect for forest spirits or observance of taboos in cutting certain trees).

Table 1. Tree species used by the interviewed Indigenous people in the construction of canoes.

Portuguese name	Scientific name	Ethnicity
Amarelão	*Apuleia leiocarpa*	Arara, Juruna, Mura, Sateré-Mawé
Andiroba	*Carapa guianensis*	Apiaká, Tenharim
Angelim-pedra	*Dinizia excelsa*	Tenharim
Angelim-pedra	*Hymenolobium petraeum*	Mura, Sateré-Mawé
Arurá	*Iryanthera grandis*	Mura
Castanha-do-pará	*Bertholletia excelsa*	Tenharim
Cedro	*Cedrela odorata*	Apiaká, Kayabi
Cedro-rosa	*Cedrela fissilis*	Guarani, Tapayuna
Cedrorana	*Cedrelinga cateniformis*	Apiaká
Cumaru	*Dipteryx odorata*	Apiaká, Kayabi, Tapayuna
Copaíba	*Copaifera* spp.	Mura
Copaíba	*Copaifera langsdorffii*	Bororo

Cupiúba	*Goupia glabra*	Mura, Sateré-Mawé, Tapayuna
Ipê-amarelo	*Handroanthus serratifolius*	Arara, Bororo, Juruna, Tapayuna
Itaúba	*Mezilaurus itauba*	Arara, Juruna, Mura, Sateré-Mawé, Tapayuna, Tenharim
Jacareúba	*Calophyllum brasiliense*	Apiaká, Mura, Tapayuna
Jarana	*Lecythis lurida*	Juruna
Jatobá	*Hymenaea courbaril*	Tenharim
Jequitibá	*Cariniana legalis*	Bororo
Louro	*Aniba guianensis*	Apiaká, Kayabi
Louro-aritu	*Licaria aritu*	Mura, Sateré-Mawé
Louro-preto	*Nectandra cuspidata*	Arara, Juruna
Maçaranduba	*Manilkara bidentata*	Mura, Sateré-Mawé
Maçaranduba	*Manilkara huberi*	Tenharim
Marupá	*Simarouba amara*	Kayabi, Mura, Tenharim
Melancieira	*Alexa grandiflora*	Arara, Juruna
Pequi	*Caryocar brasiliense*	Tapayuna
Piquiá	*Caryocar villosum*	Juruna
Piranheira	*Piranhea trifoliata*	Mura
Quaruba	*Vochysia maxima*	Juruna
Sapucaia	*Lecythis pisonis*	Tapayuna
Sucupira	*Pterodon pubescens*	Kaiowá
Sucupira-preta	*Bowdichia nitida*	Juruna
Tamboril	*Enterolobium contortisiliquum*	Kaiowá
Tamboril	*Enterolobium maximum*	Juruna
Tatajuba	*Bagassa guianensis*	Juruna, Tapayuna
Tauari	*Couratari* spp.	Mura, Sateré-Mawé
Ucuúba	*Virola surinamensis*	Tenharim

3. 2. Cultural and functional importance of canoes in indigenous life

Canoes play multiple roles in Indigenous life: in subsistence, as they enable fishing, hunting, and gathering in flooded or hard-to-reach areas; in mobility, by allowing travel between villages, the transport of goods, and participation in ritual and political events; in cosmology, as in many ethnic groups they are associated with the cycle of life, spiritual journeys, and the connection between worlds; and in the transmission of knowledge, as canoe construction is a moment of intergenerational learning.

Canoes are central to the fluvial mobility of the Apiaká people, who traditionally inhabit the banks of the Teles Pires River, a major tributary of the Tapajós River, itself a key affluent of the Amazon. These canoes, crafted from a variety of woods harvested from the Amazon rainforest, are used by the Apiaká to reach fishing and hunting sites and to visit neighboring communities. Their construction involves shared knowledge with neighboring groups such as the Munduruku. During one of our visits to an Apiaká village, we witnessed the construction of a canoe using jacareúba wood (*Calophyllum brasiliense*) and paddles made from itaúba (*Mezilaurus itauba*).

The Kayabi, also riverine inhabitants of the Teles Pires River, rely equally on canoes for survival. They are used to reach agricultural plots, gather forest products, hunt and fish, and are even present in ritual contexts. The Kayabi are known for building larger canoes, suitable for long journeys and collective use, especially in intercommunal exchanges. They use marupá (*Simarouba amara*) and cedar (*Cedrela odorata*) wood to craft lightweight canoes. Young people learn the art of canoe carving from their elders from an early age.

The Arara people build dugout canoes with robust forms to withstand the rapids of the Xingu River and its tributaries. These vessels are essential for transportation and resource collection, but also for recreation, including artisanal fishing and visiting the many islands scattered along the Xingu:

> "*We prefer to spend some time in the forest and some time on the river. It's in our nature to go into the forest. But the same urge we feel to go into the forest, enjoy nature, hunt and fish, we also feel for the river. We Arara were raised on the river; we have all that knowledge, that custom. It's very good. We miss the river. When we spend too much time without sailing, the urge grows strong, so we take a canoe and head to some island beach to fish and relax. That's the best kind of living*" (E.P. Arara, 21 years old, ♂, Arara ethnic group, Itkoum village, Arara's Big Bend of Xingu Indigenous Land, October 07, 2019).

Transportation in Arara villages is primarily done via watercraft known as "rabetas." Almost every family owns at least one rabeta, a small outboard motor manually guided with a pole to determine direction. Rabetas are widely used for navigating shallow areas and igarapés (narrow forest streams). They are employed in a range of activities, from fishing and hunting to visiting riverside villages along the Xingu River and traveling to the nearest city, Altamira. For fishing, paddled canoes are still preferred due to their silence, which facilitates the activity.

Wooden canoe maintenance continues in Arara villages. The Arara use the latex from maçaranduba (*Manilkara elata*) to caulk the vessels, and fibers or pulp from the Brazil nut tree (*Bertholletia excelsa*) to patch holes, sealing them with the latex. Preferred woods for canoe construction include *Alexa grandiflora* (melancieira), *Apuleia leiocarpa* (amarelão), and

Mezilaurus itauba (itaúba). Like the Apiaká, the Arara also favor itaúba wood for paddle-making.

In Arara and other villages, such as those of the Mura and Tenharim, old canoes are often repurposed as raised garden beds for cultivating vegetables, herbs, and medicinal plants such as cilantro, green onions, mint, boldo, ginger, mastruz, and various chili peppers. These canoe gardens are filled with soil and organic fertilizer and are suspended on wooden supports about 1.5 meters above the ground to protect them from domestic animals such as chickens and ducks.

Neighbors of the Arara in the region known as Volta Grande do Xingu, the Juruna are a traditionally riverine people who master the making of monoxylous canoes (carved from a single tree trunk) with high sides and custom paddles, but also build plank canoes. They use them for hunting, fishing, and ritual travel.

Like the Arara, the Juruna maintain a strong relationship with nature. Their livelihood depends on agriculture, forest extraction, hunting, and fishing. Their knowledge is intimately tied to forests and waterways—traditional wisdom passed down through generations. Their daily routines follow the rhythms of nature. Forest resources are not only vital for food and trade, but also for the quality of wood and fiber used in building homes, tools, and canoes.

Itaúba (*Mezilaurus itauba*) is the primary wood used for canoe construction. According to a knowledgeable Juruna elder who accompanied us during two months of expeditions along the Xingu River and its tributaries, there are two types of itaúba: yellow and black:

> "*Itaúba comes in two types, black and yellow. Both are good woods and suitable for making canoes. Amarelão [Apuleia leiocarpa] also makes a good canoe, but it's not like itaúba, which lasts the longest in water*" (M.P. Juruna, 75 years old, ♂, Paquiçamba village, Paquiçamba Indigenous Land, May 2, 2019).

"Itaúba-preta" (black itaúba) and "itaúba-amarela" (yellow itaúba) are common vernacular names used to refer to different tree species, typically within the same genus, but exhibiting distinct characteristics—particularly in terms of wood color, density, and geographical distribution. The term *itaúba* originates from the Tupi language and means "dark wood tree." The yellow variety may refer to several species with yellowish wood, still within the Lauraceae family. However, variation also occurs within *Mezilaurus itauba* itself, influenced by factors such as soil type, tree age, and environmental conditions. Therefore, we understand the color-based distinction as reflecting natural intraspecific variation within *Mezilaurus itauba*, which has led to the popular usage of the terms "yellow" and "black" to differentiate its phenotypes.

In addition to itaúba, the Juruna build canoes with wood from *Apuleia leiocarpa* (amarelão), *Caryocar villosum* (pequi), *Alexa grandiflora* (melancieira), *Enterolobium maximum* (tamboril), and *Bagassa guianensis* (tatajuba), among others. According to one Juruna canoe-builder who was crafting a canoe from amarelão on the banks of an igarapé, it takes about two days to hollow out the log with an adze, followed by fire-treatment to open the structure. If the wood cracks during the process, it is sealed with pitch. That canoe was being sold for approximately R$ 500.00 (about 110 euros in October 2019).

The maintenance of wooden canoes among the Juruna is also done locally. Pitch derived from *Protium* spp. (amescla), mixed with duck feathers, is used to seal any leaks.

Although they live near important rivers such as the Garças River, the Bororo of the Meruri Indigenous Land have traditionally emphasized terrestrial knowledge. Canoes are used mainly for crossing rivers and fishing. When they do build canoes, they prefer woods such as jequitibá (*Cariniana legalis*) and copaíba (*Copaifera langsdorffii*).

The Xavante, also inhabitants of the Cerrado biome, have little tradition in canoe usage. They are traditionally land-based hunters and walkers, relying on their own bodies for movement. Although artisanal fishing exists, it is generally conducted from the riverbank, and boats are rarely used for river travel.

In the semi-arid Northeast, the Pankararu people rarely use canoes. When they do, it's typically for marginal river crossings along the São Francisco River and not part of a central cultural practice.

Among the Guarani Ñandeva and the Kaiowá, canoe use is restricted to riverine communities. Where used, canoes carry symbolic meaning in ritual crossings and pilgrimage-related travel. Historically, along large rivers such as the Apa, Guarani canoes were used for crossings, fishing, and gathering. Today, these groups live under extreme pressure in heavily occupied territories dominated by agribusiness. In the state of Mato Grosso do Sul—home to the highest rate of Indigenous homicides in Brazil—the Kaiowá rarely use canoes, despite proximity to major rivers like the Dourados and Brilhante. In the past, when canoes were built, the wood of *Enterolobium contortisiliquum* (tamboril) was commonly used by these Guarani groups.

In a landscape mapped by rivers and streams, watercraft are indispensable to the Mura people. Historically renowned for their canoeing skills, they use small, light vessels for fishing, hunting, and quiet travel through flooded forests. However, today many Mura use aluminum boats purchased in towns: *"Back then, everything was manual—we'd grab a canoe and walk for hours and hours*."

Most of their boats are motorized canoes powered by rabetas, typically ranging from 6.5 to 15 HP. The Mura still regard *Mezilaurus itauba* (black itaúba) as the best canoe wood, due to its high resistance to xylophagous organisms (termites and fungi). Its use is recommended for naval carpentry, construction, and exposure to weather.

Evidence of Mura occupation along the Urubu River dates back to 1787. In 1875, the naturalist João Barbosa Rodrigues described their settlements, including Castanhal, Aniba, Dapaturu, Sangal, Cana, and Correnteza. Entering the Paraná do Arauató—a key channel linking the Urubu and Amazon rivers—he saw Mura canoes and traces of old settlements.

The Mura people never established their settlements deep inland; even during their period of greatest territorial expansion, they consistently sought out floodplains along the Amazon, Solimões, Negro, Japurá, and Madeira rivers, as well as their tributaries. Their primary concern was to ensure mobility by canoe, which enabled them to reach both the areas where they built their dwellings and the locations where hunting and fishing were most plentiful.

Known in colonial ethnography as the "corsairs of the river path" and feared in the 18th and 19th centuries, the Mura were at one point targeted for extermination—a campaign that ultimately failed. The term *corsair* differs from *pirate*, yet it has also been used in reference to how the historical Mura were perceived by colonial and missionary sources—as a nomadic people who sustained themselves through warfare and raiding. This characterization, however, reflects more the lens of external observers than the lived reality of the Mura themselves. For the Mura, mobility was not synonymous with disorder or aggression, but rather a strategic adaptation to the riverine environment of the Amazon and a fundamental aspect of their social

and territorial organization. The colonial attribution of predatory behavior often served to justify military campaigns and the imposition of sedentary lifestyles, ignoring the complex ecological knowledge and political autonomy embedded in Mura mobility.

The Mura and Sateré-Mawé of the Urubu Indigenous Territory build or purchase their own boats, navigating the numerous igarapés of their land. Some are built by Indigenous craftsmen, who favor itaúba (*Mezilaurus itauba*) and louro-aritu (*Licaria aritu*). *Couma guianensis* latex is used for caulking, and *Piranhea trifoliata*—a rot-resistant wood—was used historically to construct barricades in river passages during the Cabanagem revolt [7].

During our time in the Urubu Territory, we observed boats being built, although a local resident commented, "*Among the Mura, few people still build canoes*." Still, watercraft remain vital to the region. Throughout our stay, we saw a significant number of boats navigating the Urubu River and its igarapés. These vessels are used by farmers, extractivists, and fishers traveling between villages and to external contact points such as *vila de Novo Remanso*. They also use canoes to reach crops, nut groves, and fishing and hunting sites. For the Mura and Sateré-Mawé of the Urubu Indigenous Territory, as throughout Amazonian lifeways and imagery, watercraft are fundamental. They connect people to the land and to life itself in the Amazon.

The Tapayuna, a recently contacted group, share canoe-building practices with the Kayabi and other "Middle Arinos" peoples, their region of origin. According to Tapayuna elders interviewed in the Xingu Indigenous Territory, they did not use canoes in their former lands between the Arinos and Sangue rivers. Back then, they used rafts made from tree trunks tied with vines to cross large rivers. Currently, the Tapayuna use canoes for getting around near their villages, covering short distances by paddling, while aluminum motorboats are used for longer journeys.

Following two poisoning episodes against the Tapayuna in the 1950s and 1960s, and an influenza outbreak in 1970, 41 survivors were relocated to the Xingu Indigenous Park. In this new territory, through contact with other Indigenous groups and the need to travel along the Xingu River and its tributaries, the Tapayuna learned canoe-building techniques and river navigation—skills that became essential for moving between villages and accessing agricultural fields, extraction areas, as well as hunting and fishing grounds. Today, fishing appears to be primarily a male activity, and both paddle canoes and motorboats are used to reach fishing sites along the Xingu and Suiá-Miçu rivers.

The construction of canoes in the Tapayuna's original territory—located between the Arinos and do Sangue rivers (a region currently under demarcation study by the team I am working with, in preparation for the Tapayuna's return)—will be reinforced by the knowledge acquired during the period they lived in the Xingu territory, as well as by the abundance of raw materials in the region. Particularly noteworthy are the tree species *Cedrela fissilis* (cedro), *Dipteryx odorata* (cumaru), *Goupia glabra* (cupiúba), *Caryocar brasiliensis* (pequi), *Mezilaurus itauba* (itaúba), *Handroanthus serratifolius* (ipê-amarelo), *Lecythis pisonis* (sapucaia), and *Bagassa guianensis* (tatajuba). In the Xingu, the Tapayuna primarily build their canoes using wood from *Calophyllum brasiliense*, which they refer to as *landim*.

For the Tenharim people, the canoe is essential for navigating areas of dense forest and winding rivers. Their canoes are small and lightweight, traditionally made from *Simarouba amara* (marupá) and *Carapa guianensis* (andiroba), among other woods. In a landscape mapped by rivers and *igarapés* (small forest streams), these vessels are indispensable for sustaining this riverine community. The Tenharim own their own canoes, which they use to transport Brazil

nuts, access agricultural plots—mainly located along the Marmelos River—as well as hunting and fishing areas. However, according to some interviewees, "*no one builds canoes anymore. Now they buy them*". Only the maintenance of wooden vessels continues to be carried out in the Tenharim villages. In this context, the latex of *Couma guianensis* (sorvão) is still used to caulk the canoes.

Among the Indigenous groups studied, we observed that the canoe plays a vital role among riverine peoples such as the Apiaká, Arara, Juruna, Kayabi, Mura, Sateré-Mawé, and Tenharim, while its use is more limited among peoples of the Cerrado and semi-arid regions, such as the Bororo, Xavante, and Pankararu. This diversity of practices reflects distinct ecological adaptations, and where the canoe holds a central place, it is always closely tied to cosmology, mobility, and subsistence.

Below are some examples of canoe crafted by different Indigenous groups studied (Figures 2 to 6).

Figure 2. Detail of the construction of a canoe carved with an axe from a *copaíba* trunk (*Copaifera langsdorffii*) (Photo by Ropkrase Tapayuna), and two canoes documented in Tapayuna villages (Photos by Fabio Rossano Dario).

Figure 3. (A) and (B) Detail of a canoe being built by a Mura indigenous person in the Aparecida do Correnteza village, in the Rio Urubu Indigenous Land; (C) and (D) Canoes built by the Mura indigenous people, with plank structures and equipped with a 6.5 Hp motor known as a "rabeta." (Photos by Fabio Rossano Dario).

Figure 4. (A) Hull construction of a canoe made with wooden planks; (B) The canoe is nearly finished, with the side braces to hold the planks already in place, as well as the seating benches; (C) Detail of a canoe equipped with a 6.5 HP rabeta (long-tail) motor; (D) (E) (F) Detail of canoes used by riverside dwellers in the Amazon (Photos by Fabio Rossano Dario).

Figure 5. (A) Canoe documented in the Apiaká Indigenous Land, carved from a single trunk of *jacareúba* wood (*Calophyllum brasiliense*); (B) Apiaká paddle canoe docked on the banks of the Teles Pires River; (C) Kayabi paddle canoe docked on the banks of the Teles Pires River; (D) Bororo paddle canoe, documented in the Aijeako village, in the Meruri Indigenous Land, built with jequitibá wood (*Cariniana legalis*) (Photos by Fabio Rossano Dario).

Figure 6. (A) Detail of a boat being built by an Arara Indigenous person using itaúba planks (*Mezilaurus itauba*); (B) (C) (D) Tenharim paddle canoes; (E) Kayabi paddle canoe (Photos by Fabio Rossano Dario).

4. CONCLUSIONS

The analysis presented in this article demonstrates that Indigenous canoe construction in Brazil is the result of complex systems of knowledge developed through sustained interaction with rivers, forests, and materials over generations. Far from being improvised or purely intuitive, these practices involve precise measurements, proportional reasoning, and careful evaluation of environmental conditions, all of which are learned through observation, participation, and oral transmission. Ethnographic evidence from different Indigenous groups shows that such knowledge is both locally specific and broadly comparable, revealing shared principles alongside distinct cultural solutions.

By articulating canoe-building practices with concepts from ethnomathematics and the indiciary paradigm, this study reinforces the importance of recognizing Indigenous technical knowledge as systematic, coherent, and intellectually rigorous. These practices challenge hierarchical distinctions between "scientific" and "traditional" knowledge and underscore the need to value Indigenous epistemologies on their own terms. Understanding canoes as both technical artifacts and cultural expressions contributes not only to anthropological and educational debates, but also to broader discussions on sustainability, knowledge diversity, and the persistence of Indigenous ways of knowing in contemporary contexts.

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