

Discussion on the Traces of an Early Phase Lashed-Lug Boats of Southeast Asia

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ABSTRACT

Lashed-lug boat-building techniques played a significant role in Southeast Asian trading networks. The previous studies reported that approximately 20 boats in this category have been found. Indeed, an archaeological survey in Thailand during the 1990s had reported the existence of several boats of this type, but the information was scarce and no excavation had been conducted. Not until 2019, a team of Thai underwater archaeologists carried out a survey along the Andaman Coast, the resources available to conduct the work including the discovery of boat remnants which were assumed to be lashed-lug type. The first was a boat plank found at Khlong Thom, the early port site in Krabi province, likely dating back to c. 1st – 5th century CE. The second was a boat plank found at Pak-Klong Kluai beach, Ranong province, located in the area of Phukao-Thong archaeological site. Therefore, research on the boat planks is needed in order to find out the technique of the boat-building and its age. The main purpose of the research is to present an insightful analysis of the boat remnants. The analysis of boat-building techniques, a sample collection for AMS dating, and a comparative studmanguiny were carried on. The result of the study reveals a significant aspect of an early phase lashed-lug boats: planks were carved into protruding lugs with hollowed holes, the hull was secured using a palm rope and wooden wedge, and no trace of a dowel hole are found. The AMS dating of a wooden sample from both sites provided a date of 1,856 ±25 BP and 2,303 ±29 BP. Comparatively, the boat structure is similar to the lashed-lug boat of Pontian (3rd – 5th century CE). However, the hull of these boats bears a different technique of making from other boats (e.g. Butuan and Ban Khlong Yuan boats, 9th century CE). The discovery of the boat remnants in Thailand has shed new light on the early technique of constructing lashed-lug boats in Southeast Asia, confirmed by the AMS dating. Furthermore, information on boat-building development is provided.

Keywords: Lashed-lug Boat, Mortise and Tenon Boat, Shell-based Boat, Sewn Plank Boat

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INTRODUCTION

“Lashed lug” is specifically used to describe a traditional boat-building technique that spread and was used throughout Southeast Asia’s region. The technique consisted of a shell-based construction, in which the hull planking is constructed first to create an outer shell by edge joining method using wooden dowels and lacing ligatures to the pre-drill holes on the plank, sometimes only dowels are used. After the hull is assembled, frames are added to strengthen the overall construction by lashing to the lugs carved on the interior of the hull. Undoubtedly, the name “lashed lug” comes from the last procedure. Recent studies showed over 20 vessels that were identified as lashed lug boats (Manguin 2019; McGrail 2001), all of them were discovered both underwater and inland near the waterway of Indonesia, the Philippines, Malaysia, Vietnam, and also Thailand. As a result, all have been dated between the fifth to the sixteenth centuries CE (Lacsina 2019, 40).

Previous studies by several scholars have suggested a similar theory that early Southeast Asian boats might have been joined exclusively by lacing (Horridge 1982, 1, 32–33, 56–58), or at least lacing as a primary fastening and supplement with doweling (Manguin 1993, 260; McGrail 2001, 297). As Horridge (1982) asserted the need for metal technology in order to drill the dowel holes on the plank edge, which the lacing holes on the lug did not. Furthermore, Manguin (2019, 5) suggested the chronology of the development of plank fastening vessels, he stated that lashed lug boats in the early first millennium relied more on lacing than doweling. Then, during the second half of the first millennium, boatbuilders began to rely on dowelling than lacing, and toward the end of the millennium lacing were completely disappear. However, it is uncertain to conclude whether lashed lug plank fastening is evolving from exclusive lacing to exclusive doweling, without additional evidence on a much earlier plank-built boat (Lacsina 2016, 38).

The earliest well-known evidence of watercraft assembled with lashed lug is the remains of Pontian boat found in Peninsular Malaysia, dating between 260 – 430 CE (Manguin 1993, 256). Traces on the plank show sign of lacing with a small number of doweling. Moreover, in 1985, Pierre-Yves Manguin (1993, 257) investigated a similar boat's plank construction to the one at Pontian, which had been recovered and displayed at Wat Khlong Thom Museum, Krabi, Thailand. The planks are badly damaged and had no radiocarbon dating, however, relative dating suggested the age of the planks is between the fifth to the seventh centuries CE. Interestingly, the plank showed an identical lug design to its relative, the Pontian boat. Although, there is no sign of supplementing dowels, as the planks are badly degraded and were found in such a small length.

The discovery of the Pontian boat and its relative, Khlong Thom plank could represent, what assume to be an early-stage lashed lug boat. However, the available evidence is scarce and incomplete. Nonetheless, a recent survey along the coastal port sites of Khlong Thom, Krabi and Phukao Thong, Ranong, located in the Southwestern coast of Thailand had discovered a few boat remnants that can reveal a new example of an early-stage lashed lug boat.

ARCHAEOLOGICAL SITES OF LASHED-LUG BOATS IN SOUTHEAST ASIA

Archaeological evidence of vessels that were built using lashed lug technique number more than 20 throughout the region (Manguin 2019; McGrail 2001; Lacsina 2019). Despite the main concept of lashed lug construction, there is a distinctive difference in each construction. The major difference is the way planks are fastened, lashed lug vessels in the early period showed that plank stitching or lacing was a primary fastening method and supplemented with a dowel, this included the archaeological evidence of the Pontian Boat (3rd-5th CE), the Kolam Pinisi Boat (5th-7th CE), the Sambirejo Boat (7th-8th CE), the Punjulharjo Boat (7th-8th CE), and Ban Khlong Yuan Boat (early 9th CE). Later period vessels such as the five Butuan Boats (8th-10th CE), the Chau Tan shipwreck (9th CE), the Cirebon shipwreck (10th CE), the Paya Pasir timbers (12th-14th CE), the Sha Tsui Boat (13th-15th CE), the Gujangan shipwreck (15th-16th CE), and the San Isidro shipwreck (16th CE), only show evidence of doweling, discarded the practice of lacing (Manguin 1993; McGrail 2001; Liebner 2014; Lacsina 2016, 2019; Mochtar 2020). Archaeological finds supported that lashed lug technique evolved from primary plank lacing and gradually adapted to doweling (Manguin 2019; McGrail 2001).

HISTORICAL ACCOUNTS

There are very few historical accounts describing boats in Southeast Asia. As Southeast Asian most likely pass their knowledge through oral tradition (Lacsina 2016: 23). Most of the accounts are written by non-Southeast Asian. Indeed, only a few describe insight detail of ship construction.

A fourth-century Chinese book on Southeast Asian floral describes that sugar palm bark (*Arenga pinnata*) can be made into rope, which is used by Southeast Asian boatbuilders to bind timber together (Manguin 1993, 261). Another Chinese record from an eighth-century source describes the large ship of kunlun people (people beyond the barrier which refer to Southeast Asians) which they called “*bo*”. The source stated that this ship can reach 60 meters and can transport up to 1,000 passengers. The ship is bound together using the bark of coconut trees with no use of iron nails or clamps. There are several planks and sails (Manguin 1993, 262). A smaller size vessel was recorded by Wang Ta Yuan, a Chinese traveler that visit Madura during the fourteenth century. He stated that the boat was made using split rattan and plug the seam with cotton wadding (Scott 1982, 340, as cited in Lacsina 2016).

More detailed accounts were produced during the arrival of the Europeans in the region beginning in the sixteenth century CE. The first Portuguese source described the Sumatra trading ship as *junco*, the word is derived from the Malay and Javanese word *jong* (Manguin 1993, 266), which appeared in Javanese inscription as early as the eleventh century (Manguin 1993, 266; Brandes 1889). The *jong* is large ship comparable in size to the Portuguese, which can carry between 350-500 tons deadweight (Manguin 1993, 266). The plank and frame were exclusively fastened with dowels and assembled multiple layers of planking. The *jong* used at least two masts and used two lateral rudders (Manguin 1993, 266–267). Another Portuguese account written by Gabriel Rebello described a boat building in Moluccas Sea in 1569. He described that the planks are drilled at the seam and were assembled using a mallet. The construction is so tight that the seam is barely visible. Then, the boatbuilders tied the interior (component) to the lug or cleat with ropes made from root (Manguin 2019). Indeed, the first-hand account of lashed-lug boat building is the record by Francisco Alcina, a Spanish priest who recorded step-by-step boat-building techniques in the Philippines during the seventeenth century CE. He wrote that after the keel was attached to the stem and stern post, the suitable length of wood was chosen for the planks. Only two planks can be produced from a single tree, the boat-builders reduces the thickness of the plank using adzes and left a series of lug or *tambuku* (Alcina 2005 [1668], 169, as cited in Lacsina 2016; 2019).

STUDY OF EARLY LASHED LUG BOATS IN THAILAND

Pak Khlong Kluai Shipwreck Site

In 2016, a local fisherman discovered a large scale of wood remnants and pottery on the beach of Pak Khlong Kluai, Ranong province (Figure 1). The site is exposed during low tide, fortunately after the found he contact the authorities, which finally led to the Thai Fine Art Department conducting a slow process of unearthing and conserving the remains.

The Fine Arts Department including the 15th Regional Archaeology Office (Phuket) and the Underwater Archaeology Division (UAD) conducted several archaeological surveys and site mappings from August to November of 2016. The remnant was identified as a shipwreck, due to a large amount of what was assumed to be wooden planks with a mortise and tenon fastening technique, the evidence also showed many scarf joints. The individual plank has an estimated dimension of 500 centimeters in length, 30-40 centimeters in width, and 10 cm in thickness. The overall structure was 20 meters long and eight meters wide. The plank analysis from the laboratory reveals that it is *Terminalia nigrovenulosa* Pierre which is commonly found in Sri Lanka, Burma, and Thailand. The tenon was made of *Dialium cochinchinese* Pierre and the dowel was made of *Cassia* sp. AMS dating of the plank sample came out between BC 170-180 (Cal BP 2120±30, BP 2140±30) (The FAD 2017)

The site location is near Bang Kluai Canal which is linked to an early coastal archaeological site of Phukao Thong, a site that play an important role as a port, stone, and glass ornament production dating around 2,000 years ago. Unfortunately, the wooden structure was in poor condition, and an attempt to reduce the deterioration using Geotextiles and sandbags did not work. As a re-examination show the structures couldn't withstand the wave. So, the recovery excavation was planned in order to recover the main part of the wreck.

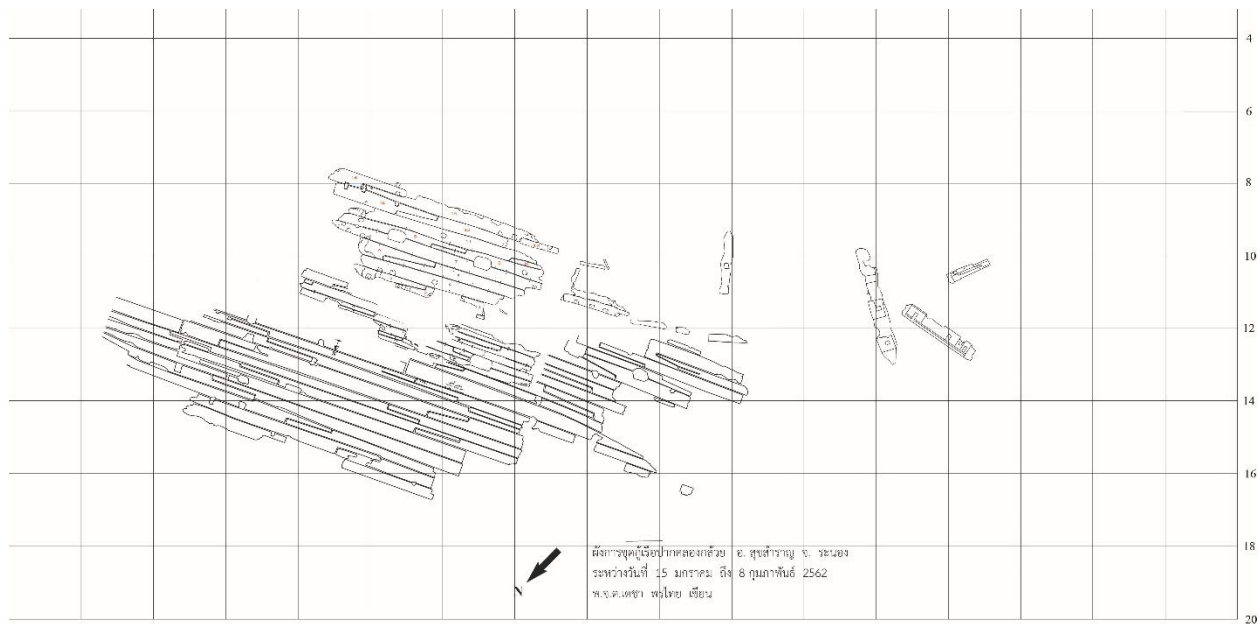


Figure 1. Map showing the shipwreck remains of Pak Khlong Kluai site between 2016-2019: Courtesy of Decha Pornthai.

The excavation was conducted in 2019, and the GPR (ground penetrating radar) was used in order to detect underground anomalies across 800 m². Test pits and trenches were planned based on this information to cover the study area. Due to the condition of the site as the wreck is exposed during low tide, the excavation process needs to be finished in one day. So, the trenches were divided into 17 long, narrow trenches and five test pits.

As a result, the main wooden structure of 60m² (the volume of the structure reduced significantly based on the 2016 report) is identified as a ship plank, the length varies, the width is between 30-40 cm, and has 10 cm thickness. It was joined edge to edge and used mortise and tenon fastening techniques and supplemented with dowels to lock the joint. Wood identification was carried out for the second time, planks were made from *Terminalia nigrovenulosa* Pierre, tenons were made of *Dialium cochinchinese* Pierre and dowels were made of *Tectona grandis* L.f. (the fifteenth Regional Office of Archaeology 2016) Traces on the plank show at least six scarf joints and two rectangular shape holes. During the recovery process, various sizes of logs are found under the structure, some showed signs of rough-cut marks and were assumed not relevant to the ship's parts, which could suggest the wrecks were likely abandoned. 80 percent of the pottery excavated from the site are orange-brown jar-shaped earthenware, decorated with cord marks. The rest of the potteries are bowl-shaped and has a variety of decoration such as impressing and polishing inside with black ash. All of them have a similar style to pottery found in Phukao Thong early historic site nearby. The AMS dating of the plank came out to be 200-140 BCE (Ploymukda 2020, 54), which is relative to artifacts found at Phukao Thong site. The remnant of mortise and tenon planks found at Pak Khlong Kluai site represent a few of these techniques that are found in Southeast Asia. However, it still remains unclear if it is part of a hull or other part, since, no further evidence of a keel or frame is found.

Surprisingly, the excavation on test pit three (including the adjoined area of trench one, and trench three) revealed different ship construction to the main wreck. The test pit is 10 meters Southwest of the wreck. Timbers lying on test pit three show clear evidence of lashed lug construction, in addition, the lug design is relatively similar to the Khlong Thom boat plank and Pontian Boat which will be discussed more in detail.

A total of three distinctive timbers were found in test pit three. They were all identified as a hull plank of a lashed lug-type vessel, as the timber is carved to create a protruding lug (Figure 2). Even though they were



Figure 2. Evidence of lashed-lug plank no. 20 from Test Pit thee.

found in the same area, planks were lying separated from one another. It was hard to consider if they were an adjacent plank or even came from the same vessel.

The most complete one is plank number 20, which is 230 cm in length, and 40 cm in width, it has six cm of plank thickness and the same lug thickness. The lug shape is relative to Pontian and Khlong Thom Boat as it shows favorable use of a rectangular design, in which lugs are almost wide as a plank and are aligned to one side, leaving an edge protruding out about three cm, hence overlapping with the adjacent plank, overlapped part is made slightly slope down to the edge. However, there are some distinctive features that appear on this broken plank, there seems to be no sign of doweling or lacing hole on the seam as appeared on other plank-lacing vessels and the lug pattern is also quite different, the evidence on this plank shows only one rectangle-shaped hole on each lug and a combination of wide and narrow lugs with a continuous ridge connected between them, though, there are some holes on the seam of this ridge, but it seems not enough. AMS dating of this plank (D-AMS 034770) was dated to 2,303 BP $\pm$ 29 or 408-357 cal BCE (Piromrak 2020, 41). This is considered the oldest lashed lug-type vessel in Thailand and probably in Southeast Asia.

The longest piece is plank number 19, which is 320 cm in length, and 60 cm in width, the thickness of the plank is four cm, the same as the lug. The condition of this piece was badly degraded; however, the evidence showed the favorable design of a rectangular lug with a single hole. On the other hand, wide lugs (dimension of 60 cm) only appear with a spacing of 60 cm, and no traces of continuous ridge, doweling holes, or plank lacing holes were found.

The last piece is plank number 17, which is the smallest 120 cm in length, 25 cm in width, and eight cm in thickness. The plank showed evidence of a center ridge lug with two holes bored through the width, however, one end has a slightly protruded lug roughly the width of the plank with six holes bored to the

surface of the lug, these holes were not drilled through the plank but bored one and a half cm deep. There was also no sign of plank-fastening methods. This timber part was unidentified which part of the vessel it was, as no evidence of this kind has ever been found before.

Evidence found at Pak Khlong Kluai site is rare and significant. The wreck's identification suggested that at least two vessels were found, one favored a mortise and tenon technique, and another favored a lashed lug technique. The dating of both wrecks suggests that both boat-building techniques existed in the same period and also related to Phukao Thong site, which played a major role as an early port site, artifacts found at this site were Indo-Roman merchandise such as granulated gold beads, precious stone carved to a lion-shape, ring carved into Roman figure and rouletted wares. The wood identification also indicated the use of Southeast Asia region woods, both vessels could be built in the region. Furthermore, sediment analysis from test pits one and four indicates that the geology of the site might be a shore instead of a sea bed (Ploymukda and Piromrak 2019, 197).

Khlong Thom Archaeological Site

In 1985, Pierre Manguin investigated boat planks displayed at Wat Khlong Thom Museum, the planks were found by a local and had been given to the museum. It was identified as lashed lug type, and features on the plank are relatively similar to Pontian boat, though no traces of dowel holes are found. The planks were relatively dated between the fifth to the seventh century CE as it is associated with the early port and beads production site of Khlong Thom (Manguin 1993, 257). Although Khlong Thom's timbers are remarkably rare, they have been overlooked for decades.

In 2019, Thai UAD conducted a survey along the canal where the plank was found in order to find more evidence about this vessel. The area along the canal is known as Khlong Thom Site (Kuan Luk-pad), an early port site on the Andaman coast that indicates an intensive overseas connection. The survey focused mainly on the canal where they were reported. As a result, the survey team found 12 damaged planks slightly buried under the sediment, the alignment was scattered and presumed not in situ. However, several planks were also found intact on the canal bank, they were assumed to have more archaeological context, however, no excavation had been conducted, but it is highly recommended in the future.

Timbers recovered from the site are identified as lashed lug type. As it was submerged in a water-logged condition, which helps preserve the organic material very well, all still have ropes residue intact (Figures 3 and 4). All of the planks were classified into two main parts, hull plank, and keel plank (Piromrak 2020, 35–41).

The hull plank

The longest piece that was recovered is 150 centimeters in length, the width is around 25 centimeters, and ten centimeters in thickness (including the plank body and the lug). Features on the plank consist of rectangle lugs measured around 40x20 centimeters, each lug has two sets of trapezoid holes (five centimeters wide) bore through the edge. These holes are lashing points for the frame as one sample of plank still has what assume to be a broken piece of frame intact and several pieces still have rope residues loosely bonded.

Each lug is 40 centimeters apart, though, one sample has a ridge connected to the others. The design of the lugs shows the intention for plank overlapping as one edge of the lug protrudes out from the plank body. In addition, the cross-section view of the lug also indicates inclination from the overlapped section to the other, which is assumed to follow the curvature of the hull. Furthermore, each corner of the lug appears to have two sets of L-shaped holes drilled through the seam of the plank, these holes acted as a plank fastening



Figure 3. Lashed lug plank no. 4 (on top) and no. 5 (long piece) with ropes residue attached to each lug.

point with ligatures, as ligature is passed through each hole on the adjacent plank to create a tensioned knot, and then supplemented with a wooden wedge bored into the knot space to create a tighter fit. However, no traces of plank doweling are found, which puts into question the strength of this vessel.

The keel planks

Two planks were identified as keel planks, as the design of the lug is distinct from the others. Lugs are placed in a fairly central position as opposed to hull planks that are adjacent to one edge. Evidence on plank #004 indicates a center ridge lug with large two holes bored through, on one end of the lug also showed L-shape lacing holes. The dimension of the fragment is 53 cm long, 28 cm wide, and 10 cm thick. This design is similar to Pontian's keel plank (Gibson-Hill 1952, 114) and Butuan 5 keel plank which were referred as carinate or ridged keel (Green et al. 1995, 185–186; Lacsina 2016, 116–117).

Another one is plank #003, the fragment piece is 49 cm long, 27 cm wide, and nine cm thick. The feature on this plank has a rectangle lug with a continued ridge. Unlike other planks, this one has L-shaped holes drilled through one side of the lug and a large hole bored through the ridge. Though the piece is very small in dimension and wasn't showed continuous evidence, the lug pattern is relatively similar to Ban Khlong Yuan Boat and Butuan Boat 4 (Lacsina 2016, 190).

Unlike the Pontian Boat, an investigation showed that the Khlong Thom plank has no evidence of doweling, the only method used for plank fastening is lacing the plank through L-shaped holes along the edge and supplementing with a wooden wedge. The use of wooden wedges is common in this vessel, as it is found in all spots that consisted of knot tightening, the relatively similar evidence of wedges was also found at Punjulharjo Boat, Indonesia.



Figure 4. Lashed-lug plank with a frame piece attached to it by ligature.

AMS dating by Direct AMS, USA, was conducted not long after the recovery of the plank. A sample of the wooden wedge (D-AMS 034772) was dated to 1,856 BP or 85-229 cal CE (calibrated with Oxcal 4.3) (Piromrak 2020, 41).

Timbers used in building Khlong Thom boat were identified into three species. The hull plank is made from *Hopea* species, the frame and wedge are made from *Mesua ferrea* L., and the seam wadding was identified as *Payena acuminata* (Blume) Pierre. Moreover, ropes used for frame lashing and plank lacing were identified as *Arenga Pinnata*. As a result, all identified timbers are commonly grown in a wet tropical area and are of Southeast Asia origin.

Other sites

Previous reports between the 1990s-2000s recorded the discovery of several lashed lug vessels found in the Southern and up to the Central part of Thailand, unfortunately, most of them were brief and lost their archaeological context due to the unwitting recovery of the locals.

The first one is remnants of boat timbers discovered at Ban Kok Yang, Trang province. The evidence showed a well-preserved early lashed lug boat recovered from an alluvial deposit. The report noted the existence of planks with integrated rectangle lugs, frames, and bulkheads, with the practice of plank lacing by ropes. No dating was ever conducted, the examination from photographs shows the relation to the Pontian boat and Khlong Thom timbers. Unfortunately, the remnants were demolished (Vatcharangkul 2001, 47).

The second one is lashed lug planks found in Khlong Ta-Noo canal, Ban Koh-Takien, Chanthaburi. The report by Thai UAD in 1997 recorded that two planks were found buried under the canal bed, and being covered by bamboo branches. Due to the bad visibility, the diver found only two planks with no associated artifacts (Parnfuk 1997, 3-5). No radiocarbon dating or wood identification was conducted, however, planks are relatively similar to the Panjulharjo and Ban Khlong Yuan Boat, with evidence of laced holes and dowel

holes. The plank is 250 cm in length, 30 cm in width, and 10 cm in thickness. It was identified as a hull plank of a lashed lug boat and shows the uses of a scarf joint.

DISCUSSION AND CONCLUSION

Recent studies of early watercraft in Thailand have revealed interesting evidence of lashed lug vessels with their planks exclusively laced together and with no traces of dowel holes. They support the theory which suggested that lashed lug boats in the early period are primarily laced together. These features are associated with the absolute dating of the plank which came out to be earlier than the Pontian Boat, lashed lug watercraft which represent a transitional phase between exclusively lacing to a combination of both methods. Indeed, the site of Pak Khlong Kluai indicated an association between mortise and tenon ship construction and lashed lug vessels, a more intensive study should address this relation. Therefore, the discovery of exclusive plank-laced vessels has inspired more curiosity about their appearance and construction, whether they are raft-type vessels or hull-plank vessels.

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