

# The Early Ninth-Century ‘Ban Khlong Yuan’ Lashed-Lug Boat of Chaiya, Peninsular Thailand: comparisons, contrasts and capabilities

Wongsakorn Rahothon (Underwater Archaeology Division, Fine Arts Department, Ministry of Culture, Thailand)

Dr Tom Vosmer (University of Western Australia, and Department of Maritime Archaeology, Western Australian Museum)

## ABSTRACT

The Underwater Archaeology Division of Thailand conducted an archaeological expedition in 2019 to trace the wreck sites in the southern peninsula. As a result, the Ban Khlong Yuan boat (BKY) was found in Surat Thani Province, southern Thailand. The area supported an urban town and seaport of the Srivijaya Kingdom between the seventh and twelfth centuries. The remains of the BKY boat were recently re-articulated. The focus of this paper is to present a brief overview of the reconstruction process, highlight analytical materials found in the wreck, and make comparisons of the BKY boat with other lashed-lug vessels of the region. A lines plan will be derived from the reconstruction of the BKY boat and the basic naval architectural data presented. AMS dating and identification of shipbuilding materials demonstrate that the BKY boat is an early ninth-century lashed-lug boat built of genus *Hopea* timber, with boatbuilding techniques comparable to the *Punjulharjo* boat (Central Java, Indonesia), the *Chau Tân* boat (Quang Ngai Province, Central Vietnam), and the *Butuan* boats (Northern Mindanao, Philippines). Comparisons of lashed-lug designs and boatbuilding techniques among these vessels will be explored. The sophisticated boat represents a boatwright’s intellect of indigenous people in Peninsular Thailand during the ninth century. The widespread lashed-lug boats found across Southeast Asian waters reflect skilled local boat-builders, mariners and middlemen who effectively engaged in transoceanic trade between the east and west at the ports of the dominant polity.

**Keywords:** lashed-lug boat, maritime archaeology, Chaiya

## List of figures and table

**Figure 1.** (a) Location of BKY boat and archaeological and ethnographic lashed-lug sites (after Manguin 2019). (b) BKY planks re-aligned. (c & d) BKY planks re-articulated. (e) Preliminary outline of BKY hull.

**Figure 2.** (a) The native ranges of timbers used in the construction of Butuan 1 and 5. *P. quadrialatus* (Philippine rosewood) is confined to the southern Philippines. (b) The native ranges of timbers used in the construction of the Intan and Cirebon ships. (c) The native ranges of timbers used in the construction of the Punjulharjo boat. (d) The Ban Khlong Yuan boat was discovered near the centre of the ranges of its timbers.

**Figure 3.** (a) Boats with continuous plank ridges. (b) Lug configurations of four Butuan boats (after Lacsina 2016). (c) Scan of Ban Khlong Yuan keel plank showing dowel and lashing holes.

**Figure 4.** (a) Remains of a composite anchor on the Belitung shipwreck site. Courtesy Michael Flecker. (b) Two of the Binh Chau anchors from Vietnam. Courtesy Ian McCann. (c) Reconstruction of a Binh Chau composite anchor. (d) Edge-drilled timber on the Phanom-Surin site in Thailand. (e) Close-up of an edge-drilled timber from the Phanom Surin vessel. (f) Process of converting a lashed-lug plank into timbers suitable for use as stringers, such as on the Phanom-Surin ship.

**Table 1.** AMS radiocarbon dating results of BKY boat samples

## INTRODUCTION

Southeast Asian maritime and underwater archaeology is still developing and in-depth watercraft studies have until recently been somewhat neglected, research criteria not always rigorously applied. For a relatively new area of enquiry an emphasis on data collection and classification is crucial (Bass 1983, 97).

Boats which feature a ‘lashed-lug’ construction technique are firmly considered to be an archetype of Southeast Asia (Miksic 2017, 566, Manguin 2019, 408; 2021, 137; Staples and Blue 2019, 275). Even though the form of the lugs among the boat remains vary, the lugs of the eponymous ‘lashed-lug’ boats are their primary defining feature. Structural features of lashed-lug boats follow an easily recognizable paradigm, but there are features that differ among vessels. This may be due to their date, region of construction, religious, spiritual or cultural traditions, regional sea and weather conditions, their intended purpose, the specific species of timbers or bindings used or even the personal preference of builders.

The Ban Khlong Yuan boat conforms to the general model of lashed-lug vessels: double-ended (i.e. pointed at each end in plan view), a keel plank rather than a standard keel, carved planks with lugs spaced at regular intervals, left proud on the inside surface, to which frames are lashed, planks edge-joined with blind dowels and (sometimes) individual discrete lashings binding planks together, no stem or stern posts but the ends of strakes connecting to carved V-shaped ‘wings’ at bow and stern, and longitudinal stringers lashed to the inside of frames. The lugs are spaced at regular intervals except in about amidships, where the keel and two planks on either side are lacking lugs. Ethnographic examples and the remains of the seventh century Punjulharjo ship (Mochtar 2018) suggest that beams or thwarts were fitted to which temporary decking could be lashed.

Manguin has done an admirable job of discerning and describing the evolutionary path of lashed-lug boats over a period of centuries from those stitched together without the use of dowels through a gradual transition to a few dowels, to more dowels and less stitching, and finally to dowels only, the discrete stitching having completely disappeared (Manguin 2019, 2021). The Ban Khlong Yuan boat lies in the middle of this evolution, displaying a pair of L-shaped holes for individual lashings on either side of the lugs and four dowels in way of the lugs and four dowels in the space between the lugs.

## **DISCOVERY OF THE BAN KHLONG YUAN BOAT**

The Ban Khlong Yuan (BKY) boat was first discovered in 2002 in Khlong Yuan village, Chaiya District, Surat Thani Province, located on the east coast of Peninsular Thailand. The unexpected find occurred when the owner of a plantation was excavating a reservoir and stumbled upon the boat's timbers. This significant discovery was later mentioned in a field survey report included in Plengmetha Khawnuna's Master's thesis (Khawnuna 2014, 183-4).

In March 2019, the Underwater Archaeology Division, Fine Arts Department, Thailand, visited the boat timbers kept by villagers in a palm plantation. The wood-crafting techniques demonstrated by the preserved wood remains showed that the archaeological remains were from an ancient lashed-lug boat. These planks represent part of a group of about forty lashed-lug boat and ship remains in Southeast Asia dating from the 1<sup>st</sup> millennium through the first half of the 2<sup>nd</sup> millennium CE (Figure 1).

Relatively few of these regional lashed-lug boat remains were found underwater—most were in waterlogged terrestrial sites, which in some cases led to relatively well-preserved remains. Unfortunately, much of the information on some of these remains is incomplete and a few of the sites have been destroyed or are inaccessible. The Punjulharjo boat from Indonesia is the most well-preserved and accessible and a classic example. Protected by mud, at least two of the Butuan boats in the Philippines are also fairly well preserved. The Ban Khlong Yuan boat tends toward the other end of the spectrum. After the planks were

**Table 1. AMS radiocarbon dating results of BKY boat samples.**

| Site | Sample Type | Submitter ID | Percentage Modern Carbon | Conventional Radiocarbon Age | Calibrated Age (IntCal 13 datasheet using OxCal 4.4) | Median Age |
|------|-------------|--------------|--------------------------|------------------------------|------------------------------------------------------|------------|
| BKY  | Organic     | cord         | 86.75 ± 0.32             | 1260 ± 30 BP                 | 668 – 779 CE                                         | 724 CE     |
| BKY  | Wood        | dowel        | 86.45 ± 0.32             | 1170 ± 30 BP                 | 771 – 918 CE                                         | 845 CE     |
| BKY  | Wood        | shell plank  | 86.12 ± 0.26             | 1200 ± 24 BP                 | 768 – 890 CE                                         | 829 CE     |

recovered by villagers they were not conserved, but stored outside and allowed to dry, leading to some shrinkage, deterioration and possible distortion.

Three samples were sent for AMS radiocarbon dating, the results demonstrating manufacture during the eight to ninth century CE (Table 1).

One plank was identified as (*Hopea* sp), a dowel as *Terminalia mucronata*.

## **BKY PLANKS**

The BKY remains comprise the lower portions of both wing-ends and nine planks—the keel plank, with five planks on one side of the keel plank and three on the other—extending from one of the preserved wing-ends over a distance of about 8.5 metres. Additionally, smaller plank fragments were collected, making a total of eighty-four disarticulated timbers.

## **CHALLENGES IN RECONSTRUCTING THE BAN KHLONG YUAN BOAT**

The process of reconstructing the Ban Khlong Yuan boat presented significant challenges due to the degraded and disarticulated state of the timbers. For clues, the lugs on the adjacent strakes must align transversely across the planks. Secondly, dowel and stitching, holes in adjacent planks must match holes. Thirdly, the keel plank and two planks each side were missing lugs in one place. A gap without lugs, or a wider spacing of lugs at one point is a common feature of lashed-lug construction, designating midships, they would need to be aligned. Following this process, we successfully aligned all the planks and one of the wing-ends (Figure 1).

The next step involved assembling the timbers into the appropriate shape, using sandbags to support the structure. After the reconstruction, a recording of the boat was taken, revealing that nearly half of the original remains were missing, making it challenging to determine the boat's full length. With the planks reassembled sections spaced at one-metre intervals were derived from direct measurement to the inside of the planking and refined to smooth anomalies.

## LINES PLAN

Part of our investigation was aimed at creating a Lines Plan from the existing remains, then running the resulting hull form through a number of naval architectural analyses to determine basic hydrostatics. The lines plan requires a number of assumptions to be made and reference to other extant lashed-lug boats.

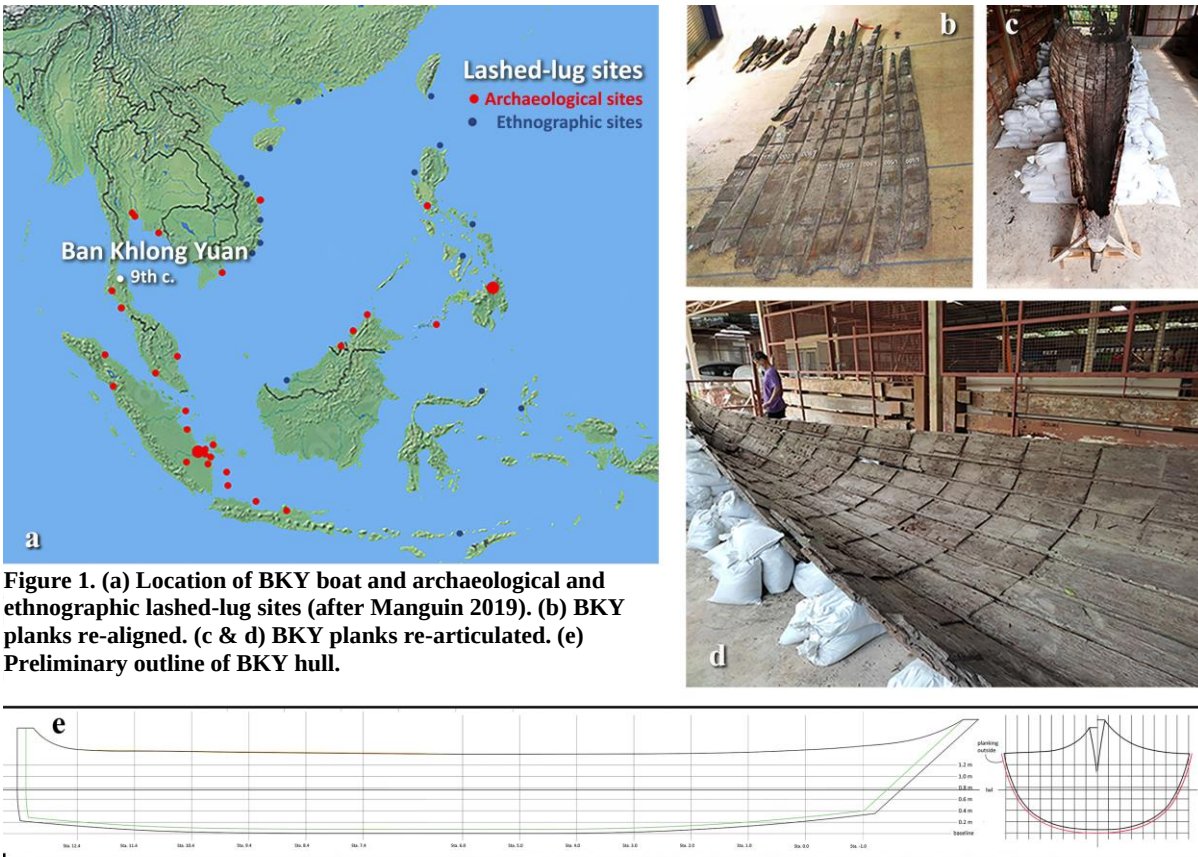


**Figure 1. (a) Location of BKY boat and archaeological and ethnographic lashed-lug sites (after Manguin 2019). (b) BKY planks re-aligned. (c & d) BKY planks re-articulated. (e) Preliminary outline of BKY hull.**

Lashed-lug boats are double-ended and roughly symmetrical in plan, so if the form of the existing hull remains could be determined, a mirror image could be created, paired with the existing hull form and integrated to the shape of the remaining isolated wing-end, which had a sharply-raked profile.

The greatest height of the extant planking was estimated to be at about the presumed waterline. With upper planking missing, the topside sectional form, the height and shape of the sheerline, as well as the maximum length and beam could only be estimated, based on boats of similar size and shape. The wings-ends provided reliable information on the form of each end.

As remarked earlier, a gap in the lug spacing near amidships is typical. The midline of this gap was about 6.87 metres from the preserved end, which suggested a keel length of about 13.74 metres. However, Lacsina states “The boatbuilders also fashioned one end of the boat on either side of the midships gap to be longer than the other side.” (Lacsina 2016, 224). Midships on Butuan 2 is 53 percent of its length from the bow, on the ship 54 percent from the bow end of the keel (Liebner 2014), on the Punjulharjo boat 55 percent of the overall length from the bow. We therefore assumed that the likely distance from amidships to the bow

end of the keel on BKY was approximately 54 percent of the overall length. Since the distance from stern end of the keel to the ‘midships’ point was 6.87, the length ahead of that point on the keel would be:

$$\frac{6.87}{46\%} = \frac{X}{54\%} \quad X = 8.06\text{m} \quad \therefore \text{ keel length} = 6.87 + 8.06 = 14.93\text{m}$$

Knowing the angle of the isolated wing-end which attaches to keel, we can then estimate the overall length of the boat. Here we have to take some guidance from ethnographic and archaeological examples as well as naval architecture.

Work toward a final hypothetical hull form is ongoing but a number of general observations can be made. BKY has a relatively flat bottom, with little deadrise and a gently curving bilge, not unlike Butuan Boat 2 in the Philippines. The ends are fine and hollow. The keel profile is relatively flat through much of its length, with bow end slightly higher.

Integrating the angled wing end into the form of the Ban Khlong Yuan hull produced a vessel about 17 metres long. The overall length of the BKY boat is nearly the same as Punjulharjo but given that about two metres of the length of BKY is in the raked bow, and the ends of Punjulharjo are essentially vertical, BKY could be proportionally a 15-metre vessel, 94 per cent of the length of Punjulharjo.

Our preliminary reconstruction produced a maximum beam of 3.34, waterline beam of 2.93 metres, depth from gunwale of 1.4 metres and waterline length of 15.46 metres on an estimated draft of .77 metres. These dimensions are very preliminary but refinement of the Lines Plan will enable hydrostatic calculations to be done with naval architecture software. However, a rough estimate of the displacement can be made on the basis of the hull form we have so far.

The rule of thumb for vessels with moderately fine ends is: displacement equals waterline length times waterline beam times draft times 0.5 (Flecker 2002, 138). Applying this formula to our dimensions:

$$\text{Displacement} = 15.46 \times 2.93 \times 0.77 \times 0.5 = 17.44 \text{ tonnes}$$

These dimensions and calculations are very preliminary but refinement of the Lines Plan is continuing and will enable hydrostatic calculations to be done with naval architecture software.

## RELATIONSHIPS TO OTHER ARCHAEOLOGICAL EVIDENCE

Our research has attempted to draw relationships among the many lashed-lug boat remains in the region and how they may relate to the BKY boat, based on specific structural features or materials used but faced a lack of detailed information as most sites have not been examined or reported in detail, their materials not identified; nor structure accurately reported, dating information lacking. That most of the timber and fibre species are widespread in Southeast Asia and were widely traded in antiquity colours the analysis. A comprehensive project to revisit sites and record data on a granular level is needed.

However, there are some species whose range is more limited, which could perhaps narrow regions of origin of some craft. Butuan 1 and 5 used timbers that, among other species, grow exclusively in the Philippines (Lacsina 2016, 196) (Figure 2). The native range of *Durio* species, identified in the Intan shipwreck, was native to Malaysia, Sumatra and Borneo, as were Punjulharjo timbers *Palaquium gutta*

and *Scorodocarpus borneensis*. The Ban Khlong Yuan boat used a *Hopea* species ranging over Southeast Asia, but a dowel was identified as *Terminalia mucronata*.

## STRUCTURAL ANALYSES

Specific features such as dowel and lug spacing, presence or absence of plank lashings, configuration of lugs, or a ridge connecting lugs might provide clues to origin, technological transfer or developmental paths.



**Figure 2.** (a) The native ranges of timbers used in the construction of Butuan 1 and 5. *P. quadrialatus* (Philippine rosewood) is confined to the southern Philippines. (b) The native ranges of timbers used in the construction of the Intan and Cirebon ships. (c) The native ranges of timbers used in the construction of the Punjulharjo boat. (d) The Ban Khlong Yuan boat was discovered near the centre of the ranges of its timbers.

The keel plank of the BKY boat possesses rectangular carved lugs with a continuous raised ridge running through the centre of the plank, a feature shared with other lashed-lug vessels such as Butuan 4 & 5 (Lacsina 2016), Chau Tân (McCann 2019, 52), the San Isidro wreck (Goddio et al. 1996, Lacsina 2016, 140), the Kolam Pinisi boat (Manguin 2019, 407), the Flying Fish wreck (Flecker and Tai 2020) and the Sungai Limau Manis boat remains (Yahya 2005, 8). The large Cirebon wreck had two planks on each side at the turn of the bilge displaying the continuous ridge (Liebner 2014, 383). Strakes above that have individual lugs, while all of the strakes below the turn of the bilge had a continuous wide ridge.

It is speculated that boatbuilders may have incorporated the ridge to increase resistance to bending. Lacsina (2016, 213) suggests that the ridge could provide structure for lashing holes drilled all the way through its width, evident on Butuan 4 and 5, and some Cirebon planks. The keel ridge could also serve as a convenient baseline from which to measure the distance from side to side as building progressed, thereby maintaining symmetry.

Lamalera boatbuilders explained that the ridge protected the hull from being worn thin when bailing water (Barnes 1985, 347; 1996, 206) but does not explain the ridge over the entire length of planks.

All these keel and plank ridges appear in widespread geographical locations and bear widely separated dates (Figure 3), lending little to illuminating any direct relationship.

## **LUG CONFIGURATION**

The shape and spacing of lugs may reveal some relationships among boats. The rectangular lug, such as on the BKY boat is the most common. That four Butuan boats display four different keel plank lug patterns (Lacsina 2016, 211) (see Figure 3) is unexpected, especially in watercraft of the same technical tradition, built at approximately the same time, and discovered in the same area. Boats 1 and 2 have multiple narrow lugs at each lug position, while Boats 4 and 5 (and possibly Boat 3) utilised a continuous raised ridge.

The earliest lashed-lug boat discovered, the Pontian boat in Malaysia, had rounded and conical-section lugs. Pairs of discrete lashings held planks together, with a single dowel fitted between them (Manguin 2019, 402, 409). Pontian shares this style of lug with the Kuan Luk Pad and Khok Yang boat remains in Thailand.

## **FRAME LASHING**

Ethnographic examples show frames lashings on individual lugs but the Punjulharjo and Flying Fish show frame lashings crossing from one plank to another (Flecker and Tai 2020, 9; Mochtar 2018). Structurally, this would make sense, as such a lashing would bind the planks more tightly together. Unfortunately, lashing of frames on the BKY boat have not survived so there is no basis for comparison.

## **DOWEL SPACING AND NUMBER**

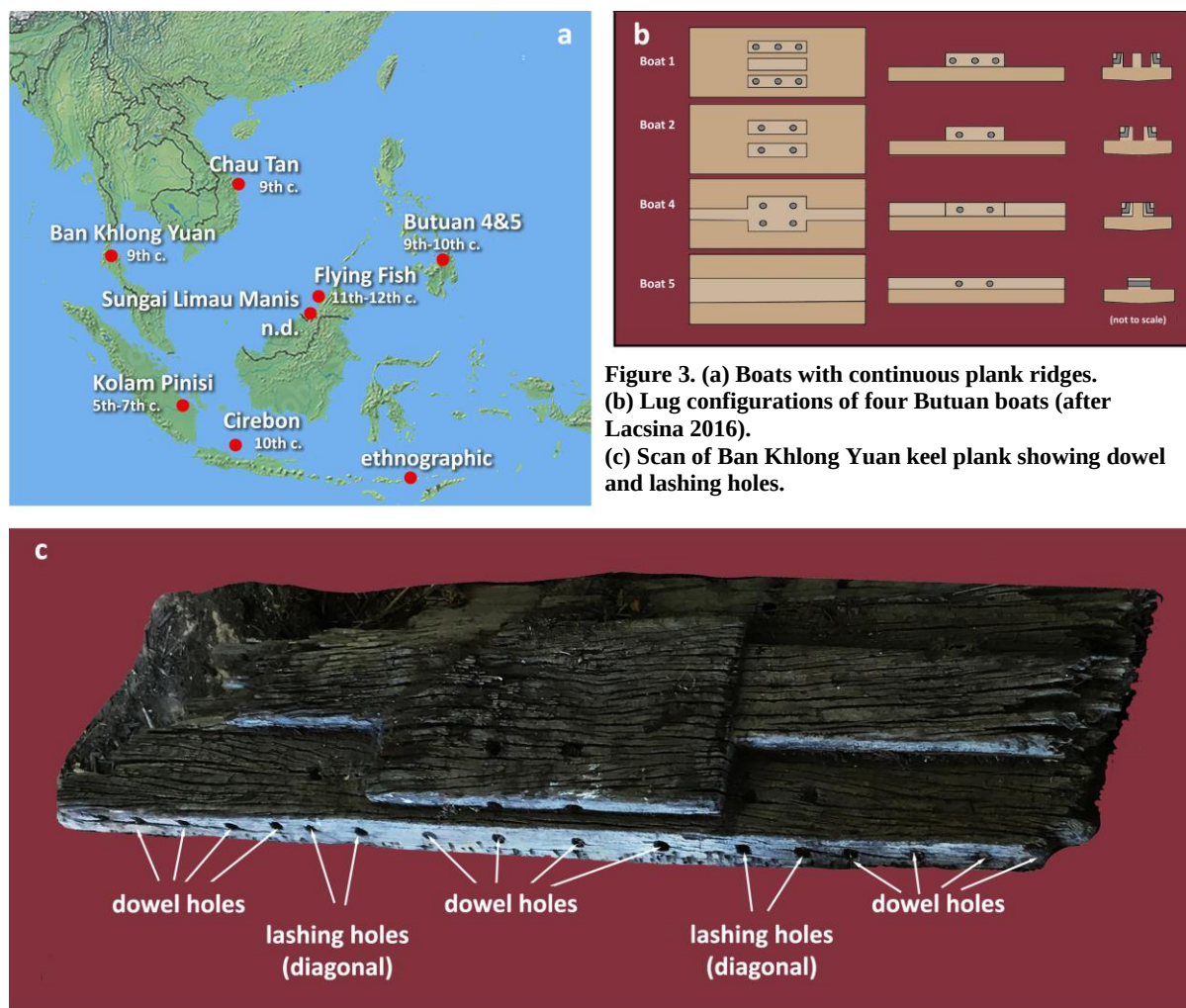
Dowel spacing or number could offer clues to origin, dating and cross-cultural exchange. Maguin has documented an evolutionary path over centuries from the use of lashing only, to the sparse use of dowels coupled with plank lashings, to increasing use of dowels and the eventual disappearance of plank lashings (Manguin 2019, 402; 2021, 138). The fifth to sixth century Kuan Luk Pad timbers and Khok Yang timbers in Thailand (undated) show no evidence of dowels, while the Pontian boat (third to fifth centuries) displays only a single dowel between lashings. The seventh to eighth century Sambirejo and Punjulharjo boats show dowel numbers increasing. The BKY boat does not have locking pins but boasts a huge number of dowels, generally four in way of each lug and four between lugs. This number of dowels seems to be a relatively late development linked with the gradual disappearance of lashings fastening the planks. The BKY boat demonstrates perhaps the height of dowel fastening prior to the abandonment of plank lashing (see Figure 3).

## COUNTER-PEGGING

In the 9-10<sup>th</sup> c. Butuan boats plank lashings have disappeared, replaced with dowels only, sometimes secured with locking pins. Locking pins are evident on Butuan 1 and 5, a plank from Sambirejo, the Cirebon ship, Paya Pasi. The practice exists today, such as with the Lamalera whaling boats of Indonesia. All are widely spaced geographically and temporally.

## MARITIME CULTURAL EXCHANGE

Examples of interaction can be highlighted which unexpectedly involve lashed-lug vessels and rare sewn-plank 'Indian Ocean style' vessels in Southeast Asia: the 9<sup>th</sup>-century Belitung shipwreck and the 8-9<sup>th</sup>-century Phanom-Surin shipwreck (Komoot 2021). Both show design and construction features associated with western Indian Ocean tradition. The two raise questions about the development of boat-building in Southeast Asia as well as the patterns and intensity of Indian Ocean trade and cultural exchange.



On board the Belitung ship was a peculiar composite anchor, a type never before seen (Flecker 2001, 344) comprising a long wooden shank, iron arms and an iron or lead collar sandwiched between them (Figure

4a-c). More recently, remains of anchors of this type, the Binh Chau and Chau Tân anchors, apparently associated with 1<sup>st</sup> millennium lashed-lug vessels were recovered in Vietnam. McCann states that there is enough evidence to conclude that these anchors and the Belitung anchor are of the same type (McCann 2019: 53).

Materials used in the Phanom-Surin sewn-plank ship are indigenous to Southeast Asia (Jumprum 2019, 243). Intriguingly, there appears to be a direct connection between the Phanom-Surin ship and lashed-lug vessels. Rectangular-section timbers have been noted on Phanom-Surin, drilled with blind and diagonal holes (Figure 4d-f) resembling lashed-lug planks. Cutting out the centre where the lugs are, one is left with long rectangular-section timbers suitable for use as stringers, pre-drilled for lashing to frames or for securing cargo.

That Phanom-Surin shipwrights were aware of the lashed-lug tradition is clear. What is puzzling is that, while edge dowels were such a significant feature of lashed-lug construction, dowels are totally absent in Phanom-Surin and Belitung.

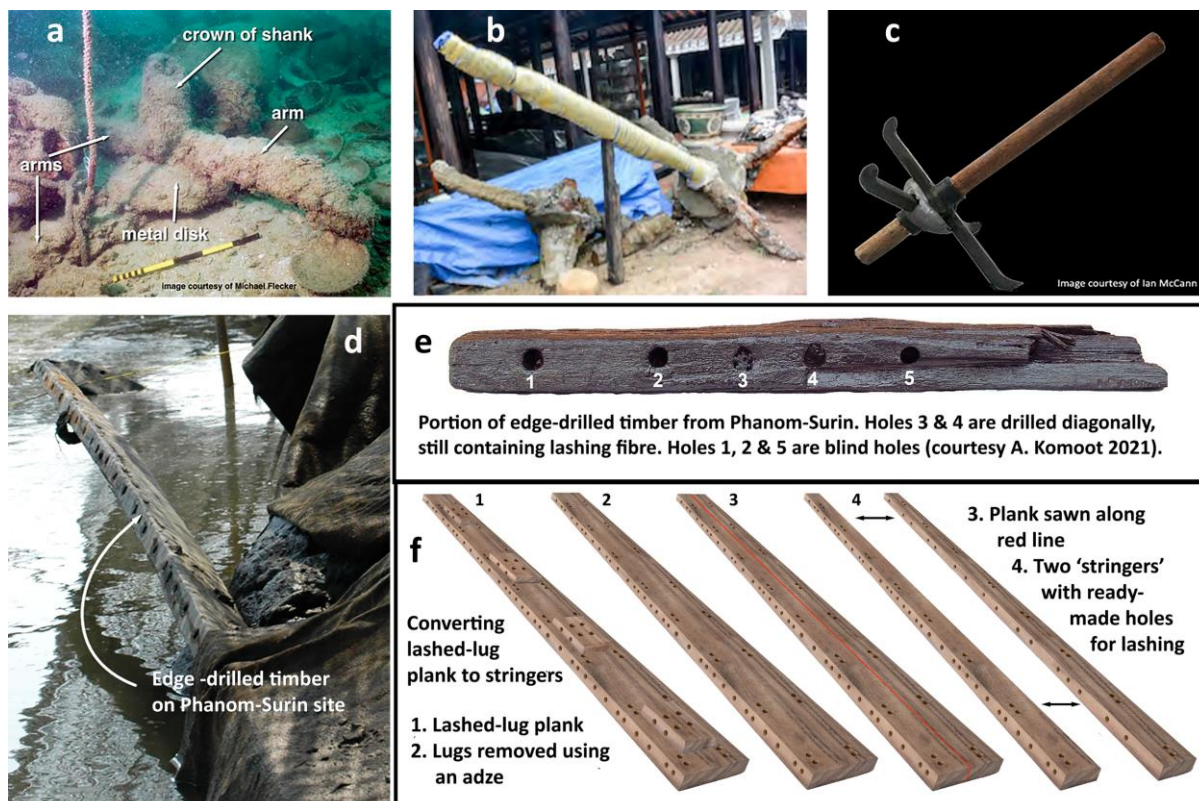


**Figure 4.** (a) Remains of a composite anchor on the Belitung shipwreck site. Courtesy Michael Flecker. (b) Two of the Binh Chau anchors from Vietnam. Courtesy Ian McCann. (c) Reconstruction of a Binh Chau composite anchor. (d) Edge-drilled timber on the Phanom Surin vessel. (f) Process of converting a lashed-lug plank into timbers suitable for use as stringers, such as on the Phanom-Surin ship.

## CONCLUSION

Despite there now being many lashed-lug remains in the region, we still do not have the detailed information required to discern meaningful technological interactions or local developments. Despite detailed reports by scholars such as Horridge (1978, 1981, 1982) Liebner (2014), Lacsina (2011, 2015, 2016, 2019, 2022) Manguin (1985, 2009, 2012, 2019, 2021), Mochtar (2018) and Purnawibowo and Mochtar (2021) which

have greatly advanced our understanding, until we amass a body of more detailed data it is difficult to define relationships or pinpoint the BKY boat's place in the milieu.

The BKY boat represents a regional trading vessel that thrived during the prosperous maritime activity of Southeast Asia in the eighth to ninth centuries and is a key illustration of the structural features marking the transition from lashed and doweled construction to boats with dowels-only near the end of the first millennium CE.

The sophisticated boatbuilding techniques observed on the BKY boat are comparable to those found in other lashed-lug boats across the region, indicating the intellectual prowess of in Southeast Asian boatwrights, reflecting keen interest in experimentation and in developing technical solutions to the challenges of producing viable sea-going watercraft. These techniques represent a shared knowledge among the ancient peoples of Southeast Asia. Lashed-lug boats are thus not solely the cultural heritage of one nation but a shared cultural heritage of Southeast Asia.

## ACKNOWLEDGEMENTS

We wish to acknowledge the Underwater Archaeology Division of the Fine Arts Department, Ministry of Culture in Thailand for their support, cooperation and encouragement in the Ban Khlong Yuan boat reconstruction project. We also thank the Archaeology Department of the University of Western Australia and the Department of Maritime Archaeology of the Western Australian Museum.

## BIBLIOGRAPHY

Barnes, Robert H. "Whaling vessels of Indonesia." In *Sewn Plank Boats*, edited by Sean McGrail and Eric Kentley, 345-366. Greenwich: British Archaeological Reports International Series 276, National Maritime Museum, 1985.

Barnes, Robert H. "Sea hunters of Indonesia: Fishers and weavers of Lamalera." Oxford: Clarendon Press, 1996.

Bass, George F. "A plea for historical particularism." In *Shipwreck anthropology*, edited by Richard A. Gould, 91-104. Albuquerque: University of New Mexico Press, 1983.

Flecker, Michael. "A Ninth-Century AD Arab or Indian Shipwreck in Indonesia: First Evidence for Direct Trade with China." *World Archaeology* 32 no. 3, (2001): 335- 354.

Flecker, Michael and Yew Seng Tai, "The Flying Fish Wreck: An Early 12th Century Southeast Asian Ship with a Chinese Cargo." *Sabah Museum Journal* 3, (2019): 1-42.

Goddio, Franck, Monique Crick and Patrice Sandin. *San Isidro wreck '96: Excavation's preliminary report and ceramic cargo's study*. Manila: National Museum, 1996.

Horridge, Adrian. *The design of planked boats of the Moluccas*. Greenwich: National Maritime Museum, 1978.

Horridge, Adrian. "The ancient planked boats of the islands east of Asia." In *Five hundred years of nautical science 1500-1900, Proceedings of the Third International Reunion for the History of Nautical Science and Hydrography*, edited by Derek Howse. Greenwich: National Maritime Museum, (1981): 241-258.

Horridge, Adrian. "*The lashed-lug boat of the eastern archipelagoes, the Alcina MS and the Lomblen whaling boats*." Greenwich: Maritime Monographs and Reports. Trustees of the National Maritime Museum, 1982.

Jumprong, Preeyanuch. "Recovery of a lost Arab-styled ship at Phanom-Surin the wetland excavation site in central Thailand." In *Ancient maritime cross-cultural exchanges: archaeological research in Thailand*, edited by Amara Srisuchat and Wilfried Giessler. Bangkok: Fine Arts Department, Ministry of Culture, (2019): 226-247.

Khawnuna, Plengmetha. *The Cultural Development of the Ancient Communities in Chaiya District, Surat Thani Province*. Master's Thesis, Department of Archaeology, Graduate School, Silpakorn University, 2014.

Komoot, Abhirada. "Maritime connections in the Indian Ocean world during the late first Millennium CE through an archaeological study of Phanom-Surin ship in Thailand." PhD thesis, University of Western Australia, 2021.

Lacsina, Ligaya. "Traditional island Southeast Asian watercraft in Philippine archaeological sites." (2011). <https://api.semanticscholar.org/CorpusID:216561888>

Lacsina, Ligaya. "The Butuan Boats of the Philippines: Southeast Asian edge-joined and lashed-lug watercraft." *Bulletin of the Australian Institute of Maritime Archaeology* 39, (2015): 126–132.

Lacsina, Ligaya. "Examining pre-colonial Southeast Asian boatbuilding: An archaeological study of the Butuan Boats and the use of edge-joined planking in local and regional construction techniques." PhD thesis, Flinders University, 2016.

Lacsina, Ligaya. "The same-same boatbuilding tradition? Looking at different examples of lashed-lug boats from the Southeast Asian region." *Proceedings of the International Symposium (15th–16th June 2017)*. (2019): 38-53.

Lacsina, Ligaya. "From the Site to the Museum: archaeologically excavated Butuan boat remains displayed in the National Museum of the Philippines." *Bulletin of the National Museum of Ethnology* 47 no. 1 (2022): 63-85.

Liebner, Horst Hubertus. "The Siren of Cirebon, a tenth-century trading vessel lost in the Java Sea." PhD thesis, The University of Leeds, 2014.

Manguin, Pierre-Yves. "Sewn-plank craft of South-East Asia." In *Sewn Plank Boats*, edited by Sean McGrail and Eric Kentley, 319-343. BAR International Series 276, Greenwich: National Maritime Museum, 1985.

Manguin, Pierre-Yves. "The boat remains of Punjulharjo: A preliminary report." Paris: École française d'Extrême-Orient, 3-4, 2009.

Manguin, Pierre-Yves. "Asian ship-building traditions in the Indian Ocean at the dawn of European expansion." In: *The Trading World of the Indian Ocean, 1500-1800*, edited by Om Prakash, in *History of Science, Philosophy and Culture in Indian Civilization*, Volume III, Part 7, edited by Debi Prasad Chattopadhyaya, 597-629. Delhi: Pearson, 2012.

Manguin, Pierre-Yves. "Sewn Boats of Southeast Asia: the stitched-plank and lashed-lug tradition." *International Journal of Nautical Archaeology*, 48 no. 2, 2019: 400–415.

Manguin, Pierre-Yves. "The assembly of hulls in Southeast Asian shipbuilding traditions: from lashings to treenails," *Archaeonautica* 21 (2021): 137–140. Available at: <https://doi.org/10.4000/archaeonautica.2397>

McCann, Ian. "The Binh Chau anchors: a 7<sup>th</sup>-8<sup>th</sup> CE Composite Conundrum: Master's thesis, University of New England, 2019.

Miksic, John. "Ships, Sailors and Kingdoms of Ancient Southeast Asia." In *The Sea in History – The Ancient World*, edited by Christian Buchet, Pascal Arnaud, and Philip de Souza, 560–572 Martlesham: Boydell & Brewer, 2017.

Mochtar, Agni Sesaria. "The Seventh-Century Punjulharjo Boat from Indonesia: A study of the early Southeast Asian lashed-lug boatbuilding tradition." Master's thesis, Flinders University, Adelaide, (2018).

Purnawibowo, Stanov. and Mochtar, Agni Sesaria. "Analisis teknologi pembuatan perahu pada temuan sisa perahu kuno dari abad VII M situs Bongal, pantai barat Sumatera Utara." ("Boatbuilding Technology Analysis of the Seventh Century Boat Remains from Bongal Site on the West Coast of North Sumatera"), *Majalah Arkeologi* 30 no. 2 (2021): 99-112.

Staples, Eric. and Blue, Lucy. "Archaeological, historical and ethnographic approaches to the study of sewn boats-past, present and future." *International Journal of Nautical Archaeology* 48, no. 2, (2019): 269–285.

Yahya, Matzin bin Haji) *The Boats of Brunei Darussalam*, Brunei: Brunei Museums Department, 2005.