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The Thaikkal-Kadakkarappally Boat: an Archaeological Example of Medieval Shipbuilding in the Western Indian Ocean

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Recent excavations at Kadakkarappally in Kerala, south-west India, have unearthed the remains of an iron-fastened boat, believed to predate the earliest known records for the use of iron in South Asian boatbuilding. The design departs significantly from the traditional view of Indian watercraft, although the use of locally available timber and the suitability of the design for use in the backwaters that characterise the region suggest that it was built and used in India. This is the first excavation of its type to take place in Kerala and contradicts the belief, widely held in Kerala, that the survival of organic remains has been negated by the tropical climate of the region.

Key words: Kerala, India, maritime history, boat technology, iron fastenings, tradition.

Archaeological investigations in 2002–2003 have unearthed an interesting boat at Kadakkarappally in Kerala, south-west India. The method of construction employed in the boat, which has no known parallels, and the well-preserved condition of the wood, make this a unique discovery. Traces of the boat were first noticed by local villagers while digging a paddy field for coconut cultivation during the early 1990s. Subsequent inspections by Parameshwaran Nair, P. K. Gopi and P. Sreedharan of the Department of Archaeology, Government of Kerala, confirmed the discovery and excavations were conducted in 2002 and 2003 by the Centre for Heritage Studies (CHS), Tripunithura, and the Department of Archaeology (Tomalin, 2003; Nair *et al*., 2004; Selvakumar *et al*., in press). Following these excavations the CHS contacted Dr Lucy Blue of the Centre for Maritime Archaeology (CMA), University of Southampton. The CMA subsequently became involved with the project in an advisory capacity during the 2003 season of excavations.

Kerala, also commonly known as Malabar, comprises the narrow strip of land situated on the south-west tip of the Indian subcontinent, flanked on the west by the Arabian Sea and on the east by the mountains of the Western Ghats (Fig. 1). The coastline is *c.*560 km long and there are 41 west-flowing rivers that connect the mountains with the sea through several estuaries, lakes and lagoons, interconnected by a string of backwaters. Maritime activity and the use of watercraft have thus been central to life for many of its inhabitants from ancient times (Tomalin, 2003). In particular, the region's geographical position, favourable monsoon winds and the abundance of desirable export commodities, primarily pepper

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Figure 1. Location Map of Kerala. (Victoria Tomalin)

and other spices and timber, have placed it at the heart of Indian Ocean trade networks.

Despite a rich history of maritime activities, very little research into Kerala's maritime archaeological history has been undertaken. Shipwreck archaeology has been non-existent. In India as a whole, no intact remains of pre-modern vessels have been found off the coast. Vosmer (1999: 296) notes that violent storms and heavy swell associated with the south-west monsoon (June to October) rapidly destroy any exposed remains while the voracious marine crustaceans, molluscs and bacteria that thrive in the warm Indian Ocean waters quickly devour any surviving timbers. Thus any ancient craft that have been preserved are only likely to be found in very deep water buried beneath the seabed.

The few archaeological examples of South Asian boats that have been excavated are only found inland (McGrail, 2001: 250). In Kerala it is generally believed that the survival of archaeological materials, especially organic remains, has been limited by the heavy monsoon rains, warm temperatures and high humidity that characterise the tropical climate of the region (Mahotra *et al*., 2001). The well-preserved remains unearthed at Kadakkarappally, however, suggest greater potential for the survival of archaeological remains than is traditionally thought, especially in the waterlogged areas along the coastal and riverine tracts.

This article outlines the results of two seasons of excavations at Kadakkarappally in 2002 and 2003 and identifies the significance of the find in relation to our present knowledge of Indian Ocean shipbuilding and the future of archaeological research in Kerala.

The Thaikkal-Kadakkarappally boat

Kadakkarappally is a sleepy village *c*.30 km south of Cochin (Kochi) near Thaikkal in the Alleppey (Alappuzha) District of Kerala (Fig. 2). This part of Kerala is well known for its backwaters and canals and Vembanad Lake that separates the Alleppey land-stretch from the mainland and opens to the Arabian Sea close to Cochin. At present the village of Kadakkarappally lies 1.5 km from the shoreline, but coastal emergence in the area, estimated at a rate of 5 km every 2000 years, suggests that the site would have been on the shore during the early medieval period (pers. comm. Shajan). This is also suggested in the name Kadakkarappally, *kadakkara* meaning seashore.

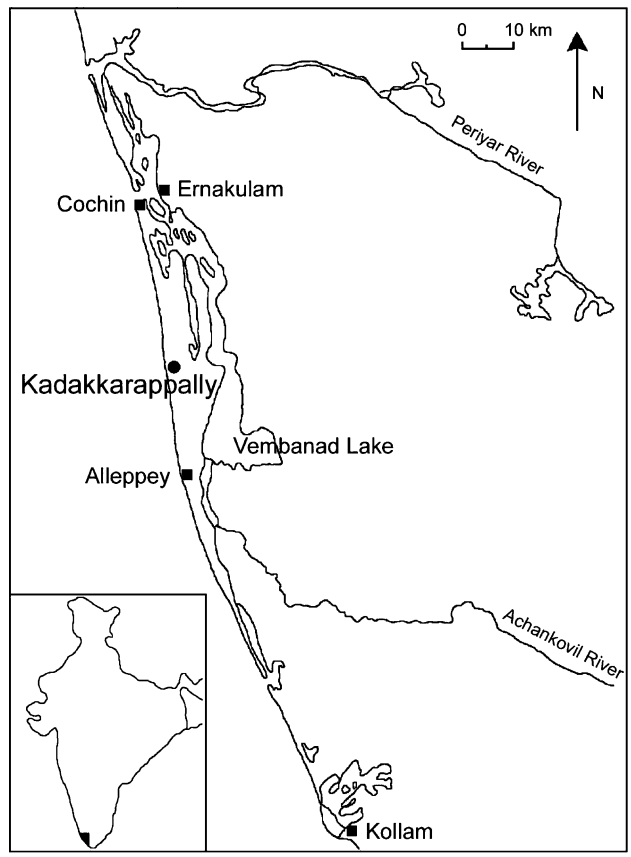

Figure 2. Location Map of Kadakkarappally. (Selvakumar)

The excavations conducted in 2002 revealed only the midship and stern parts of the boat. The second season of excavations, in April-May 2003, has nearly exposed the complete dimensions and details of the boat. Two trenches (KPY I and KPY II) were excavated at the site (Fig. 3). KPY I (30 m × 12 m), revealed the boat and KPY II (10 m × 5 m) was excavated to study the associated stratigraphy. Due to the waterlogged condition of the site, the excavation progressed slowly and pumps were used to drain the water during the excavations.

The intact portion of the double-masted, flat-bottomed boat measures about 18.7 m in length and 4.05 m in width (Fig. 4). The double-planked hull, with an inner layer of *c.*8 cm thickness and an outer layer of *c.*7 cm, is widest amidships (Fig. 5) and the bow appears to be rising to a point. Unfortunately, the stern end of the boat was destroyed by local people digging for 'treasure', although timbers lying detached from the rear of the boat, no longer in their original position, suggest that it may have had a transom.

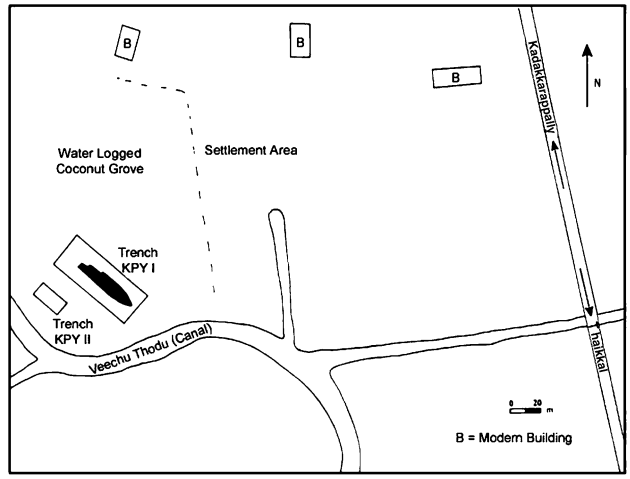

Figure 3. Location of Trenches in Kadakkarappally. (Selvakumar)

Figure 4. The Thaikkal-Kadakkarappally boat. (Victoria Tomalin)

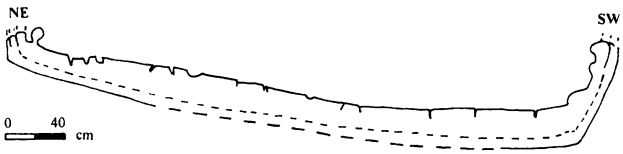

Figure 5. Transverse profile amidships (dashes indicate assumed lines to be confirmed by further excavation). (Selvakumar)

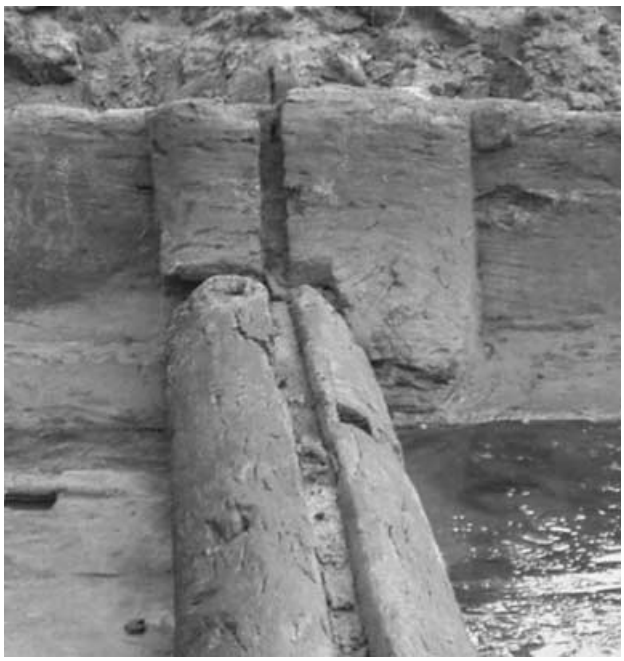

Figure 6. Socket carved into the chine to receive the frame and slots along the frame for bulkhead planks. (Victoria Tomalin)

The actual length of the boat could have been around 21 m.

The method of construction is remarkable and unique within the region. Longitudinal strength comes from two chine strakes (shaped longitudinal timbers located between the bottom and side strakes, also often called a 'transition' strake) with L-shaped cross-sections, approximately 14.5 m long and each carved from a single log of wood. Ten frames, measuring *c*.22 cm in height (moulding), *c*.35 cm in width (siding) and with varying length, divide the boat into 11 compartments and provide transverse strength. The straight frames, also formed from single pieces of timber, span the bottom of the boat and are inserted into sockets carved into the chines (Fig. 6). Wooden planks have been slotted into the frames to form bulkheads (Fig. 7). Between these frames, crossbeams appear to have been mounted upon supports carved into the side planking. The beams themselves survive only in the bow portion although the supports can be identified throughout the boat. Stanchions are regularly placed throughout the boat, although there is no evidence for what they were supporting, as the upper sections of the boat have not survived.

Several iron nails and wooden pegs of various dimensions have been used in the construction. The outer planking appears to have been secured to the inner planking by square-sectioned iron nails clenched over roves, the impressions of which can be seen on the internal side planking (Fig. 8). At the chine the two layers seem to have been additionally secured with square wooden pegs, although the exact nature of these fastenings requires further investigation. Nails in the bottom planking of the boat are without roves and in places look as if they have been driven through a rectangular lap joint, between adjacent bottom planks, to form a close-fitting seal (Fig. 9). It is, however, impossible to confirm the use of such seams throughout the boat at the present stage of excavation. Iron spikes and square-sectioned wooden pegs have both been employed to fasten the frames to the planking. Several transverse rows of cleats, carved into the inner planks of the boat, suggest that the planks may also have been held together through compression by lashings. A few rope fragments still remain within the cleats (Fig. 10).

Both the masts have been destroyed although the mast-steps remain intact. One mast-step is in the centre of the boat (Fig. 11) and the other is in the bow portion. The mast-steps have sockets for inserting the masts, but these are remarkably shallow with a depth of only *c*.5 cm. This suggests that further support would have been required for the masts and that these steps would only have functioned to fix the foot of the mast.

A large amount of pottery and animal bones was found in the excavations but stratigraphic evidence reveals that they are intrusions, deposited during later periods. The artefacts recovered from the boat include iron nails and rope fragments, which were used in the boat's construction, a large quantity of shells (window pan oyster, *Territella* and *Sunneta*) and a dressed stone measuring *c*.83 cm × 34–22 cm × 27–18 cm (Fig. 12). The stone, found in the fourth compartment from the bow, was made out of beach rock or *kankar* stone. The purpose of the stone, which is narrower at one end than the other is unclear. It could have been used as an anchor although, unlike other stone anchors found in eastern and western coasts of India (Kapitan, 1987; Gaur *et al*., 2000), it does

not have any hole to fasten the rope. It is possible that the rope was tied around the stone or that the part with the hole was broken. Alternatively, it might have served as ballast.

Wood samples from the boat were identified by the Birbal Shahni Institute of Palaeobotany, Lucknow, and the Kerala Forest Research Institute. The main timber species employed in the construction of the boat is *Artocarpus hirsutus* Lamk., known as *anjily* in the local language Malayalam. *Anjily* is a very common tree in Kerala and it is still used today for boatbuilding in this part of the country. Of the nine wood samples identified, seven are *anjily*. One fragment has been identified as *Cassia fistula* Linn. (*kanikonna* in Malayalam), and the other as *Rhizophora mucronata* Poir. (*panachikandal* in Malayalam) (Guleria *et al*., 2003). *Cassia fistula* has been used for the bulkheads, and *Rhizophora mucronata* was found in the form of a peg inserted into a perforation in the bulkhead, perhaps post-dating the construction of the boat.

The lack of any significant finds of cargo or ballast suggests that, unless these were salvaged in more modern periods, the boat was deliberately abandoned rather than wrecked. Repairs to the hull suggest that the vessel had been in use for some time. The well-preserved condition of the boat suggests that this area has been continuously waterlogged from the final abandonment of the boat. It is most probable that this area was a backwater when the boat was abandoned. The remains lie close to a canal which local stories suggest was once 30 m wide, but due to long-term sediment deposition is now not much more than a stream through the field.

Two samples from the boat have been radiocarbon dated. An initial sample (BS-1982) was tested by the Birbal Sahni Institute of Palaeobotany, Lucknow, and indicated a calibrated date of 920–1160 AD. A second sample was taken by Dr Ralph Pederson for testing at the American laboratory Beta Analytic and a calibrated age of 1020–1270 AD was obtained (Beta-179729) (pers. comm. R. Pedersen). It has not been possible, however, to relate these dates to the time of felling as neither sample has been confirmed as coming from the sapwood of the parent tree. According to Dr. K. M. Bhat, head of the Wood Science Division, Kerala Forest Research Institute, on average an *anjily* tree would take at least 40 years to attain the minimum 1 m diameter and 15 m height required to shape the substantial chine timbers employed in the boat. There is no data available on the upper age limit of *anjily*, although in general trees undergo a period of senescence after 100–150 years depending on the site and growing conditions. Therefore, we can place the maximum age of *anjily* wood used in the construction of the boat at around 200 years. Assuming that the dated wood is from the heartwood the boat can tentatively be placed within the 13th to 15th centuries AD. If a firm date for the boat is to be determined then several more samples from strategic points throughout the boat need to be taken.

Discussion

The combination of technological features employed in the boat and the locality of its discovery suggest that the Thaikkal-Kadakkarappally boat was employed to transport people or commodities between the coastal ports and the interior through the backwaters and rivers that empty into Vembanad Lake. The flat bottom and strong double-planked hull would have been well suited for the negotiation of shallow backwater channels.

The design of the boat, however, has no known parallels and appears to have little in common with the traditional types of watercraft constructed and used in Kerala. Ethnographic accounts of the 19th and 20th century attest to the predominance of dug-out canoes, catamaran rafts and sewn plank boats (Buchanan, 1807: 419; Edye, 1833; Hornell, 1946: 212–17; Rajamanickam and Arulraj, 1991; Greeshmalatha and Rajamanickam, 1993). Kerala is particularly well known for its logboats which have often been imported by countries without a developed logboat-building industry, such as the Arab world and Tamil Nadu (Kentley, 2003: 178–9). The use of nails to fasten plank-built boats has been reported in modern surveys of Kerala's watercraft (Rajamanickam and Arulraj, 1991; Greeshmalatha and Rajamanickam, 1993) but the antiquity of this practice is unknown.

It has commonly been accepted that sewn vessels were the only indigenous technology in the western Indian Ocean before European techniques were introduced with the arrival of Vasco de Gama's Portuguese fleet in 1498 (Moreland, 1939: 184; Hourani, 1951: 93; Qaisar, 1998: 25; McGrail, 2001: 77). The *Yuktikalpataru*, an 11th century treatise on shipbuilding written by Bhoja, the famous king of Malwa (present day Madhya Pradesh), states that iron must not be used in boats as magnetic rocks in the sea would drag iron-fastened vessels to their doom (quoted

Figure 7. Remains of bulkhead planking slotted into frame. (Victoria Tomalin)

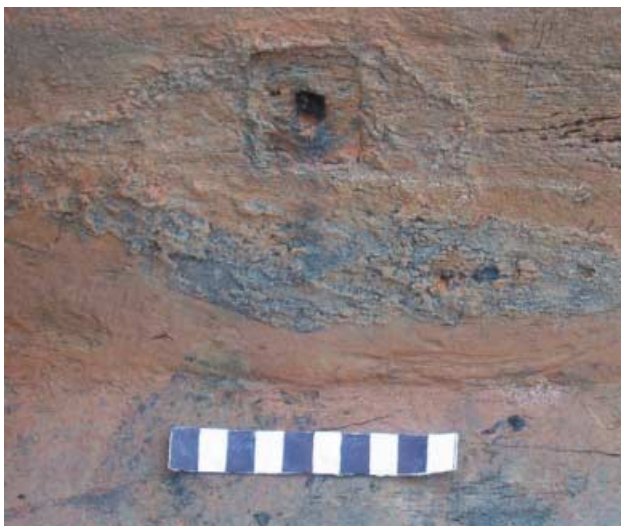

Figure 8. Imprint of corroded iron fastening. (Victoria Tomalin)

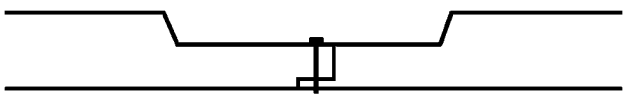

Figure 9. Diagram of rectangular lap joints between bottom planks and suggested manner of iron fastenings. (Victoria Tomalin)

Figure 10. Cleat carved into the bottom planking and containing fragments of rope. (Victoria Tomalin)

Figure 11. Central mast-step. (Victoria Tomalin)

Figure 12. Possible stone anchor. (Jesse Ransley)

in Mookerji, 1912: 14). In the 13th century the Italian missionary John of Montecorvino observed that Indian vessels, 'are mighty frail and uncouth with no iron in them and no caulking' (Yule, 1916: 66), an observation repeated in the accounts of many European travellers such as Castanheda (quoted in Moreland, 1935: 178), Duarte Barbosa (Dames, 1918: 76) and Fra Pauline da San Bartolomeo (quoted in Greeshmalatha and Rajamanickam 1993: 39).

It is only at the beginning of the 16th century that sources begin to note the presence of iron

fastenings in Indian ships, such as the accounts of Pedro Alvares Cabral (quoted in Qaisar, 1998: 25), Ludovico di Varthema (Badger and Jones, 1863: 152) and Gaspar Correa (Stanley, 1869: 240). The Thaikkal-Kadakkarappally boat, therefore, departs significantly from the traditional view of Indian shipbuilding and, if the boat was built no later than the 15th century, as the radiocarbon dates suggest, implies that Malabar shipwrights may have been using iron fastenings long before the arrival of the Europeans.

During the medieval period Kerala was at the heart of Indian Ocean trade networks and merchants of many different nationalities flocked to the Malabar coast to exchange their goods (Tomalin, 2003: 24–8). Local shipwrights, therefore, would have encountered a wide range of vessels, many of which would have required repair after their long voyages, and it is reasonable to presume that they would have had a good understanding of foreign technologies, possibly adopting particular aspects of these designs in their own vessels.

Iron-fastened Chinese junks had long been known in the ports of the Kerala coast (Tomalin, 2003: 16, 19, 21–5). Trade contacts between Kerala and China are suggested from the 6th century AD, and under the Tang dynasty (618–907 AD) Malabar became the westernmost destination for Chinese ships (Raghava Varier, 1990: 691). Lewis (1973: 249) suggests that in the Late Medieval period junks were built in China, Indonesia and India, termed by Manguin (1985: 17) the 'South China Sea Tradition', with variable characteristics pertaining to their country of origin. Indian and Indonesian junks, for example, were built from teak rather than fir and fish oil was substituted for oakum caulking. Lewis (1973: 249) refers to a mid 14th century description by John of Marignola (Yule, 1916: 230) of a voyage in which he 'embarked on board certain junks, from Lower India which is called Minibar' (the old Arabic word for Malabar). He also notes Varthema's description of *giunchi* (junk) from Tenasserim in southern India (Badger and Jones, 1863: 210).

These references are fairly ambiguous and do not necessarily imply that Chinese-style junks were built in India, but only that vessels termed junks by foreign observers were operating in Indian waters. Several characteristics of the Thaikkal-Kadakkarappally boat, however, do suggest a strong Chinese influence. Green (1990: 360) suggests that the characteristics of Chinese shipbuilding include watertight bulkheads, a lack of keel, stem or stern post, a flat bottom, rectangular cross-section, multi-layered planking and a transom bow and stern. While this represents only one strand of Chinese shipbuilding, and variations do occur, there are notable similarities between this description and that of the Thaikkal-Kadakkarappally boat. For example, the boat is flat-bottomed with a rectangular profile, no keel, stem or stern post has been identified and the hull is planked with two layers. Timbers found detached from the rear of the boat are believed to represent a transom stern although the bow appears to be rising to a point. In addition, the boat is divided into 11 compartments by bulkheads formed by partitions slotted into the frames.

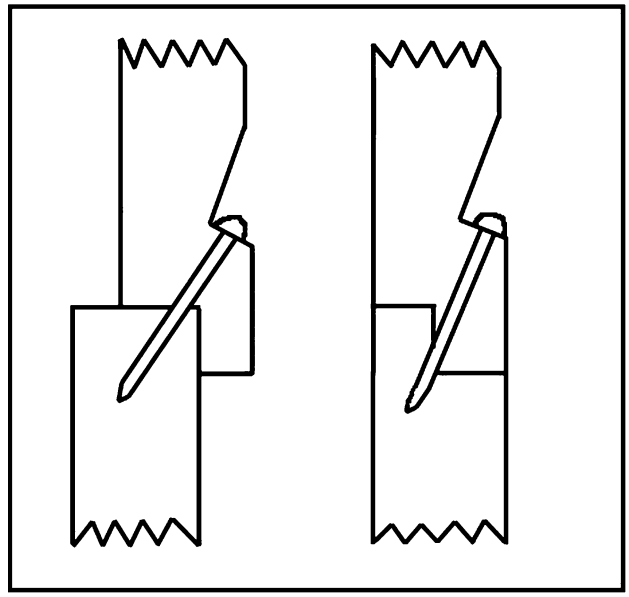

Figure 13. Distinctive Chinese method of nailed plank fastenings, two types noted in the 13th century Quanzhou ship. (after McGrail, 2001: 365)

These similarities may indicate that iron fastenings were also adopted as a result of Chinese influence on design. The use of externally-driven, unriveted iron spikes to fasten framing and planking together, as identified in the remains at Kadakkarappally, is also a feature recognised in excavated examples of medieval Chinese vessels (McGrail, 2001: 375). The distinctive Chinese method of nailing planks along the seams with recessed, angled spikes driven through rabbets (Fig. 13), however, has little in common with the plank fastenings observed in the Thaikkal-Kadakkarappally boat. In particular, clenched iron nails, where the protruding point of a nail is deformed over a rove to form a second head, is a feature explicitly identified with North-West European clinker boatbuilding and not

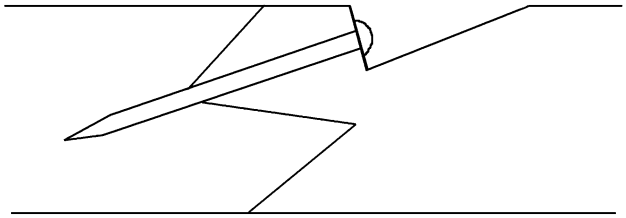

Figure 14. Vadhera technique of plank fastening. (after Hornell, 1930: 311)

commonly associated with shipbuilding in the Western Indian Ocean (McGrail, 1987: 138).

In his 16th century text Gaspar Correa (Stanley, 1869: 240–1) described vessels observed at the port of Cannanore, in northern Kerala, that: 'have the planks nailed with thin nails with broad heads, riveted inside with other heads fitted on, and also broad ... Inside, instead of decks, they have chambers and compartments made for merchandise ... The ships which are thus sewn with coir have keels, and those with nails have not, but are flat bottomed'. There are obvious similarities between this description and the remains excavated at Kadakkarappally. The accuracy of Correa's description of riveted nails, however, has been questioned by Manguin (1985: 11) who suggested that planks can only have been joined by nails driven obliquely through plank seams. Manguin refers to a modern rabbeting technique used in Gujarat, known as *vadhera*, in which the longitudinal edges of planks are fitted together with z-shaped grooves and secured by iron spikes driven obliquely through the join (Fig. 14) (Hornell, 1930). Riveted nails are then used to fasten the watertight planking to the frames. Manguin suggests that the *vadhera* technique is closely reminiscent of the angled iron nails used in Chinese vessels. For example, in the 13th century Chinese vessel excavated at Quanzhou, the inner layer of planking reveals iron spikes driven through the rabbeted plank seams (Fig. 13) (McGrail, 2001: 365).

It is unclear, however, why Manguin suggests that nails could only have been driven obliquely, apart from the absence of evidence for any other nailed fastening techniques in Indian Ocean shipbuilding. As outlined above, there is some suggestion that in the bottom planking of the Thaikkal-Kadakkarappally boat nails have been driven at right angles through lap-joints between adjacent planks, although these are not regularly placed along the planking and appear not to be clenched. Nails clenched over a rove, however, are not used to fasten the planking together along the seams but to fasten the two layers of hull planking together. Correa's description, therefore, may be more accurate than Manguin assumes. Regular spiking, in the *vadhera* or in the Chinese manner, has not been identified, although externally-driven spikes would not be visible on the internal hull planking and the external face of the hull is yet to be fully explored.

Cleats carved into the inner faces of the planking, however, suggest that the planks were also held together through compression by lashings, in which case, regularly-placed iron spikes or nails may not have been required. The use of lashings through cleats or 'lugs' is a fastening technique characteristic of South-East Asian boat building (McGrail, 2001: 304–8). Trade contacts between Kerala and South-East Asia are believed to have commenced following the decline in trade with the West after the collapse of the Roman Empire (Rao, 1970: 96). This trade continued through the medieval period and the presence of South-East Asian vessels in the waters off the Malabar coast, therefore, may also have influenced the design of locally-constructed vessels.

The Thaikkal-Kadakkarappally boat, therefore, has features in common with several different traditions of boatbuilding. The form of the boat appears to mirror one strand of Chinese boatbuilding and the lashed lugs are a feature commonly found in South-East Asian shipbuilding. The use of lap joints between adjacent planks is typically Indian while nails clenched over a rove are normally only identified with north European building traditions. The boat itself, however, was clearly built locally. All three species of wood identified in the remains are indigenous to Kerala. *Anjily*, in particular, is used for almost all of the plank-built craft in Kerala today as it is strong, resilient, fairly cheap and widely available (Rajamanickam and Arulraj, 1991: 87). It is possible that the boat was constructed by foreign shipbuilders settled in Kerala, but there is no reason to conclude that the Thaikkal-Kadakkarappally boat is not an Indian vessel, built in India by Indian shipbuilders.

The use of chine strakes may add additional support to the conclusion that the boat was designed and built in Kerala, even though they are a feature not commonly associated with South Asian boatbuilding. Kentley (2003) refers to the use of chine strakes in the Sri Lankan *madel paruwa*. Unlike the vessel excavated at Kadakkarappally, however, the chine strakes are C-shaped in cross section rather than L-shaped and the vessel is typically much shorter at *c*.10 m

long, scow-ended, propelled only by rowing and fastened by sewing (Kentley, 2003: 167–170). Kentley argues, however, that boats with chine strakes are most likely to be found where there is an active logboat building tradition and that this way of constructing a plank boat is, 'the product of a logboat-building mentality' (Kentley, 2003: 183). He highlights how the chine strake has often been characterised as a half-logboat, although the *paruwa's* chine strakes would form a hollow log rather than a logboat if fitted together and the timbers excavated at Kadakkarappally are simply too big to have come from the same log. Kentley additionally suggests that the failure of Tamil Nadu, Sri Lanka's closest neighbour, to develop a craft similar to the *paruwa* is related to its lack of a logboat building industry (Kentley, 2003: 179). In Kerala, however, where the logboat building industry is highly developed, it may not be so surprising to find a vessel constructed with chine strakes.

It is possible that the appearance of this technique in medieval Kerala may suggest historic contacts with Sri Lanka just as trade contacts may be posited to explain other apparent foreign influences on the design of the Thaikkal-Kadakkarappally boat. Kentley (2003: 181–3) notes, however, that boats built with chine strakes have been recorded in Central America, south-west France, on the Venetian *sandolo puparin* and the gondola as well as in Sri Lanka. While it is quite possible that the development of the chine strake from logboats may explain the appearance of the technique in each of these countries, it is less likely that foreign influence could account for the appearance of the same feature in four geographically separate areas.

The idea of a 'tradition' as an interpretative tool is commonly employed in archaeology to sort classes of evidence into territorially-distinct, bounded units. This enables archaeologists to compare and contrast different 'traditions' or 'cultures' in order to identify contacts between groups and the diffusion of technology or ideas. As McGrail (1995: 139) states, however, a 'tradition' is a form of classification constructed by us to aid interpretation, 'an abstraction from reality'.

The relative lack of detailed research and evidence for Indian shipbuilding, especially when compared to that available for north European or Mediterranean shipbuilding, has resulted in many studies looking to external shipbuilding 'traditions' to elucidate the nature of indigenous technologies. For example, the sewn plank boats of modern Kerala have often been interpreted with recourse to Arab shipbuilding (Hornell, 1946: 213; Manguin, 1985: 3) while Hornell's ethnographic studies of Indian vessels led him to conclude that they mirrored ancient Egyptian and Mediterranean vessels, 'so closely that they vivify scenes on the Nile or the Tigris in the days of Rameses and Assurbanipal' (Hornell, 1920: 140). The interpretation of boat technology in this manner, however, does not allow for change or indigenous innovation in design and Hornell's approach in particular has been widely criticised, for example by McGrail (1987: 1).

Adams (2001: 302) suggests that, in order to utilise the concept of a tradition, studies need to reconsider these artificial constructs with regard to the 'significance and meanings these assemblages had for those who built and used them in the past'. A number of characteristics in Asiatic shipbuilding can be found from the Indian Ocean through South-East Asia into the China Sea, as far north as Japan (Green, 1990: 361). While the Thaikkal-Kadakkarappally boat may exhibit such characteristics, it is questionable whether shipbuilders in Kerala and shipbuilders in Japan, for example, would have conceived themselves as belonging to a single tradition over this wide geographical area.

Adams (2001: 302) argues that the form of a vessel is constrained by the availability of materials, economic and technological resources, the environment in which it was employed and the uses to which it was put. He also recognises that the design is additionally influenced by a system of ideas about what boats and ships are and how they should be designed and constructed in a particular place and time. Attempts to categorise vessels by their similarities, therefore, may be masking more fundamental questions about their individual and indigenous development in accordance with local needs and requirements, beliefs and ideology.

This does not deny that technological exchanges took place or that contacts between two countries may be reflected in their shipbuilding technologies. Neither does it deny that groups of shipbuilders built boats and ships in a particular way, often for fairly long periods of time. Tradition on a local scale, in terms of 'we've always done it this way', plays an important role in how boats are perceived and designed by individual boatbuilders (Adams, 2001: 302). To assume that boatbuilders would only have built in a certain way because of the tradition of which they were part, however, only serves to deny the capacity for technological innovation, change and adaptation.

The Thaikkal-Kadakkarappally boat is the first to be discovered in Kerala, and, as outlined above, only a handful of such excavations have taken place in India as a whole. It is, therefore, virtually impossible to interpret the boat in an indigenous shipbuilding context. Until we gain a better understanding of this boat and the development of shipbuilding technology in Kerala, however, it may be counter-productive to assume that the boat is not the product of indigenous innovation and design.

As already mentioned, it is widely believed in Kerala that hostile environmental conditions have precluded the survival of organic material in archaeological contexts in Kerala. The discovery of the remains at Kadakkarappally, however, suggests a far greater potential for preservation than was once thought. The marshy lowlands of Kerala are characterised by sandbars, beach ridges, spits, barriers, estuaries, backwaters and other fluvio-marine landforms and remain waterlogged for the majority of the year (Ramachandran Nair, 1986: 43). The rivers originating in the Western Ghats carry an enormous sediment load, most of which is discharged into the backwaters or estuaries, and high levels of erosion and accretion are characteristic of the region. Contrary to popular Keralan belief this waterlogging and heavy sedimentation may in fact have actively promoted the survival of organic remains as they are rapidly sealed in an anaerobic environment. The potential for preservation in such an environment has also been noted in the deltaic coastal regions of northern Orissa by Blue *et al.* (1997: 206). This suggests, therefore, that although the warm waters, violent storms and heavy swell may preclude the discovery of shipwrecks in the Arabian Sea, systematic exploration of the banks and beds of backwaters, lagoons and channels and of former river courses may prove useful to expanding our knowledge of the history of shipbuilding in Kerala.

Conclusion

The discovery of the Thaikkal-Kadakkarappally boat is of great significance for the future of archaeology in Kerala. The state of preservation of the remains suggests that it is wrong to assume that the archaeological signatures of Kerala's past have been destroyed and it is probable that systematic investigation and excavation in the waterlogged, sedimentary lowlands of the region may reveal a wealth of undiscovered material.

The combination of technological features may have serious implications for our current knowledge of shipbuilding in the western Indian Ocean. Kerala's position in the trade networks of the Indian Ocean brought a diverse range of ships to the Malabar coast and the multitude of foreign influences observed in the boat suggest that a range of technologies may be reflected in vessels built in the region. Further examination of the history of shipbuilding in Kerala, therefore, may reveal much about the nature of technological change and adaptation in the Indian Ocean. In addition, if a pre-European date for the remains can be confirmed, then traditional theories concerning the use of iron in Indian shipbuilding are brought into question, especially the possibility that clenched nails may have developed as an indigenous innovation unconnected with north European shipbuilding traditions.

The excavations at Kadakkarappally, however, have not yet been completed and there are many aspects of the boat which need further investigation before a definitive description can be provided and comparisons with other forms of boat- and shipbuilding can be fully explored. In addition, until fresh dating evidence can be obtained, and comparable remains are found at other sites in the region, it is impossible to elucidate the extent to which it was characteristic of medieval boatbuilding in Kerala or simply a unique experiment.

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