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# Evidence for Pharaonic Seagoing Ships at Mersa/Wadi Gawasis, Egypt

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Cedar ship-timbers and associated debris from Mersa/Wadi Gawasis on the Red Sea provide direct evidence for seafaring in complex watercraft built with standard Egyptian shipbuilding technologies. The Middle Kingdom craft buried at Dashur and disassembled timbers from Lisht (*c.*1850 and 1950 BC) provide the best parallels for most of the Gawasis finds, but two steering-oar blades are more comparable to early New Kingdom examples. A new type of hull-construction technology is presented, along with descriptions of maritime artefacts and site activities.



*Key words:* shipbuilding, ancient Egypt, archaeology, cedar, Punt, Mersa Gawasis.

Excavation of the remains of seagoing ships at Wadi/Mersa Gawasis, on the Egyptian Red Sea coast, in 2004–05 and 2005–06 provides extensive physical evidence for construction techniques, wood selection, and recycling and re-use practices of the ancient Egyptians. Discoveries at Gawasis prove that common Egyptian river-oriented design and construction techniques were successful both on the Nile and at sea. In addition, a previously-unrecorded construction technology is attested in the articulated remains of small-craft planks fastened by small mortise-and-tenon joints and ligatures. The multi-component site south of Safaga on the Red Sea was in use by the Old Kingdom, but most finds are of Middle Kingdom date (*c.*1956–1650 BC). In this article, we offer a site description, a preliminary review of ship-timbers and associated maritime artefacts from the 2004–06 seasons, and briefly compare the finds to Egyptian, Mediterranean, and later sewn watercraft.

Archaeologists and naval architects have speculated about the nature of ancient seagoing ships in Egypt (for example, Mariette, 1877; Landström, 1970; Wachsmann, 1998) but such efforts were stymied by a lack of remains of seagoing ships. Survey and excavation at Gawasis in 1976 and 1977 by A. M. H. Sayed of the University of Alexandria (1977; 1978; 1980; 1983) uncovered cut-off ends of thick cedar planks with paired, unlocked mortise-and-tenon joints, abundant food-storage ceramics and painted ostraka, and unfinished anchors. On the nearby headland, early Middle Kingdom shrines built of inscribed limestone anchors supplied details of successful voyages to Punt. In 1994, underwater survey of the anchorage by the Institute of Nautical Archaeology (INA) identified only a 19th-century European-style anchor (Haldane, 1996).

In 2001 Rodolfo Fattovich of the University of Naples 'l'Orientale' (UNO) and Kathryn Bard of Boston University (BU) began survey work at Gawasis, resulting in the 2004 discovery of a complex of rooms carved into an uplifted fossil-coral terrace 12 m above a long-dry lagoon (Bard and Fattovich, 2007). Ongoing excavations at Gawasis testify to its long history as a staging-point for long-distance seafaring on the Red Sea, with industrial areas for firing pottery, baking bread, and ship-breaking. Ceramic and other finds


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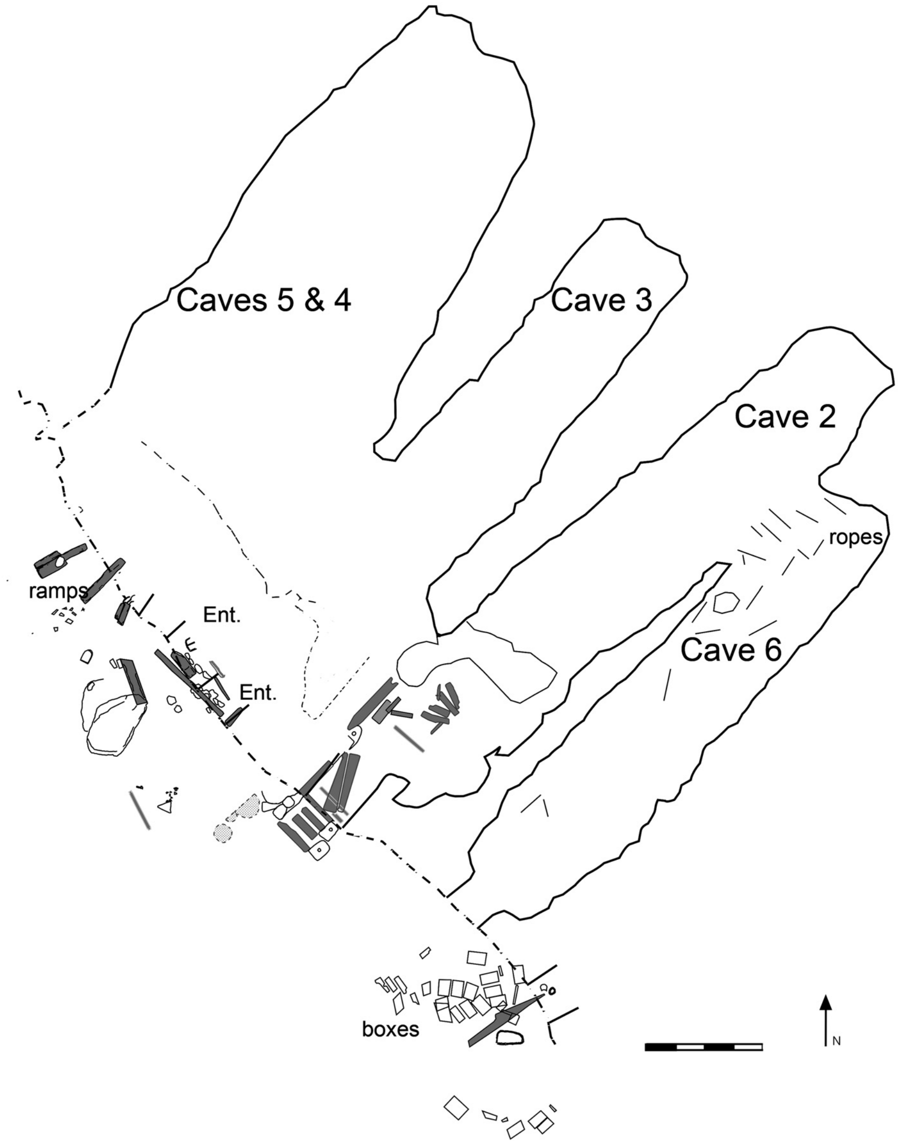


*Figure 1.* Ship components from the 2004–05 and 2005–06 seasons at Mersa/Wadi Gawasis are highlighted in this plan. (BU/UNO)

indicate sporadic visits in the late Old Kingdom (5th–6th Dynasty, *c.*2487–2181 BC), relatively frequent use in the early Middle Kingdom (late-11th, 12th and 13th Dynasties, *c.*2055–1650 BC), and rarely in the early New Kingdom (18th Dynasty, *c.*1550–1295 BC) (Bard *et al.*, 2007; Bard and Fattovich, 2007: 241–2).

## Site description and methods

Ancient visitors to Gawasis used the eroded face of the coral terrace as a shelter, and later carved at least seven long rooms into it, expanding the protection it offered (Fig. 1) (Bard and Fattovich, 2007). In 2004–05 project archaeologists Chiara Zazzaro and Cinzia Perlingieri excavated and recorded wooden objects recovered from Cave 1 (WG28), where they found reworked ship planks and wooden box fragments. The entrance to Cave 2 (WG24) was buried under more than 6 m of sand with another 0.7 to 1 m of sand mixed with grass fragments and other organic material in the opening. Zazzaro (forthcoming) recognized two large wooden objects lying flat on a deposit of windblown sand as steering-oar blades (Fig. 2). As the excavation continued, Zazzaro encountered other fragments from boxes, furniture, and thick planks (*c.*15 cm) with the remains of mortise-and-tenon joints, all in contexts of discard, re-use, or recycling in ramps, entrances and walkways.

 

*Figure 2.* Steering-oar blades lay exposed atop a deep deposit of windblown sand in the entrance to Cave 2. (BU/UNO)

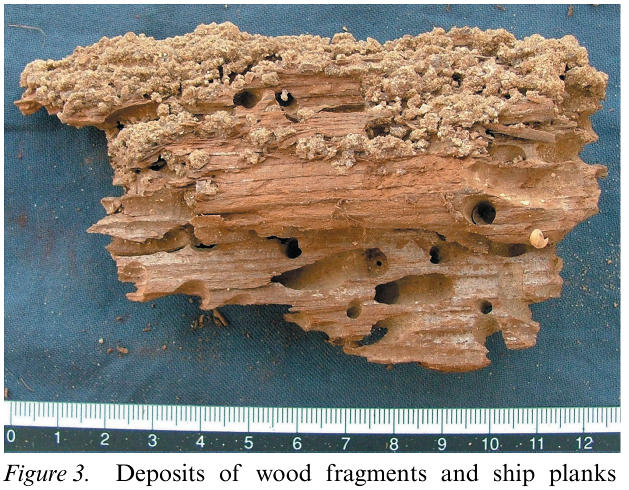


*Figure 3.* Deposits of wood fragments and ship planks included many examples with extensive damage from marine borers. (BU/UNO)

In 2005–06, excavation targeted the protected areas immediately outside Caves 2, 3, 4 and 6 in addition to ongoing work inside Cave 2 (Bard and Fattovich, 2007). Archaeologists collected about 1000 wood-debris fragments in general lots from stratigraphic units (SU). Each lot (W1–W166) received brief scrutiny and recording by Ward (Ward, 2007). Aggressive removal of wood damaged by marine borers seems to have produced most of the debitage (Fig. 3). As archaeologists encountered substantial timbers, each was defined, cleaned, and mapped as quickly as possible to reduce exposure to sun and wind. When possible, the timber was transferred to one of the ancient rooms where it was measured, drawn and described in detail, and recorded using digital photography. The condition of some pieces required *in situ* recording, and moving these sometimes resulted in disarticulation.

Fifty-four wood artefacts were identified as ship components or maritime equipment (T1–T60, not inclusive). After documentation, these timbers were classified into five types based on original function (Tables 1 and 2) as discussed below. Planks and wood fragments of unidentified function are classified as 'other'. Identifiable components of other artefacts such as boxes or furniture included in wood debris from excavation units were designated 'small finds' and are not considered here. Most planks and lots are stored on site at Gawasis, but representative examples (plank T34, steering-oar blades T1 and T2, and plank T12, among others) are curated in

**Table 1.** *Distribution of timber types*

| Timber type | Number | Wood |
|---|---|---|
| Transverse timbers (Type 1) | 1 | cedar |
| Hull-planks (Type 2) | 16, possibly 17 | cedar |
| Deck-planks, chamfered (Type 3) | 8, possibly 10 | cedar, sycomore |
| Planks with ligatures (Type 4) | 5 | acacia |
| Auxiliary equipment (Type 5) | 6 | acacia, cedar |
| Other planks, undetermined | 12 | |
| Fastenings and debitage | T38, T40 and lots W1-W166 | acacia tenons |

**Table 2.** *Typological characteristics*

| Type | Relevant dimensions | Defining characteristics |
|---|---|---|
| Type 1 | — | transverse structural timber |
| Type 2 | 65–225 mm thick | deep mortise-and-tenon joints, gribble |
| Type 3 | 750–900 × 200–350 × 50 mm or less | chamfered ends on lower face |
| Type 4 | 25–42 mm thick | shallow mortise-and-tenon joints, ligatures |

Supreme Council of Antiquities storage facilities at Quft in the Nile Valley.

## Cave and artefact dating at Gawasis

The stratigraphic sequencing of the *loci* at Gawasis is complex. The site was re-used an undetermined number of times over at least 700 years, from the late Old Kingdom or early First Intermediate Period (*c.*2200–2100 BC), to the abundant remains of the Middle Kingdom, and briefly into the early New Kingdom (*c.*1600–1400 BC) (Bard and Fattovich, 2007). Occupation during this time was episodic yet intense, with up to several thousand people living and working at the site at one time. The rooms (called caves in excavation *loci*) at all periods seem to be work and storage areas, yet few artefacts were found within them other than wood remains and the extensive cordage deposit.

Ceramic finds are critical for dating phases within the caves, and painstaking evaluation of these finds leads Zazzaro to identify two principal phases of use, based primarily on her excavation of Cave 2. Here features dating to the first phase include mudbricks and plank fragments T3 and T4 (Type 2) and T48 of indeterminable type. The plank fragments lay atop bedrock in the cave and established a level floor and walkway in an area where the bedrock is very irregular. Recycled Type 2 hull-planks T16, T20, T21, T24, and Type 3 deck-planks T17 and T22 also belong to this phase, but instead served to reinforce the entrance to Cave 2. The first phase ended with a salt encrustation 1–5 cm thick which overlay sediments outside and extended 8 m into Cave 2 beyond the entrance.

At present, Zazzaro dates the second phase entirely to the New Kingdom on the basis of ceramic evidence. It has two sub-phases, an older (sub-phase 1) indicated by the use of recycled ship-planks to stabilize the floor, and a more recent (sub-phase 2) characterized by a thick deposit of wood debris, fasteners, and rope fragments mixed in heavy sand. The placement of the steering-oar blades marks the end of sub-phase 2 and the abandonment of Cave 2. During sub-phase 1, reworked Type 2 hull-planks T5, T6, T18 and T19 functioned as a ramp into the cave. Deeper inside, Type 2 hull-planks T28, T27, T39 and T42 were cut from larger timbers, then laid closely together, probably to stabilize a walkway.

In sub-phase 2, the cave was at least partially filled with sand and the remains of extensive woodworking, including wood-chips, broken fasteners, plank fragments of a variety of origins, branches, leaves and other artefacts including some related to food-processing. Deck-planks T8 and T9, and Type 5 plank T10, are associated with this sub-phase. Also associated with this period are the remains of late Second Intermediate Period/early New Kingdom ceramics (*c.*1600–1400 BC) (Perlingieri, 2007: 122–4). The extensive fragmentary wood remains attest to woodworking inside the cave during sub-phase 2. Up to January 2006, only the first quarter of the cave's 24-m length was excavated, and the limited number of datable artefacts visible on the floor did not allow Zazzaro to assign phases to the remains of teredo-infested planks, marine shells, and ropes found there. While the construction of these Cave 2 ramps and floors is dated to the New Kingdom, Middle Kingdom sherds are also present throughout the heavy sand layer with its wood debris. It is not certain that the manufacture of planks used in these features should be dated to the same period as the New Kingdom ceramics. It is entirely possible that New Kingdom visitors to the site re-used planks originally deposited in the Middle Kingdom.

Several small hearths with charcoal and ceramic components and early Middle Kingdom pottery provide evidence for ephemeral visitation in Caves 3 and 4, but no dating sequence was established for these rooms in 2006. Cave 3 is 22 m long. No sand was deposited over its floor, which consisted of a layer of marine shell mixed with wood fragments, including broken trapezoidal tenons and dovetail tenons. Many of the wood fragments include channels and shells indicative of shipworm infestation. In Cave 4, marine shell and wood fragments were recorded, as were the remains of charred Type 2 hull-planks and crutch T44, but rock-fall and a heavy sand deposit obscured most of its contents. We suggest that artefacts on the floors attest to the trimming and reworking of planks in Cave 3 and Cave 4.

## Ship remains at Gawasis

The following description of ship components begins with the results of wood identification and is organized by type, reflecting basic categories of transverse structural reinforcement, ship hull-planks (identified by marine-borer remains and analogies with rivercraft), deck-planks (identified by analogy), small sewn-boat planks (identified by fastening system), and auxiliary maritime equipment. Representative examples of each type are illustrated. Fastenings, inscribed marks, and other maritime artefacts are then described. Much of the comparative data is drawn from Ward's documentation of rivercraft (Haldane, 1984; 1990; 1992; Ward, 2000; 2003; 2004; 2006), but some details have not been published previously.

### *Wood identification*

Imported cedar, Nile acacia (*Acacia nilotica*), and sycomore fig (*Ficus sycomorus*) woods dominate the maritime finds. Identification of representative ship components and equipment by Rainer Gerisch (2007; Bard *et al.*, 2007: 147) suggests that preferences for particular species are demonstrable (Table 1). For example, all Type 2 plank samples are cedar (*Cedrus libani*) from the Levant. Other plank-types and equipment are re-worked cedar, Nile acacia, or the locally-available sycomore fig. All identified wood fastenings are Nile acacia. We suggest that a repair to a cedar steering-oar blade infested by shipworm (T2a) was made en route, as the replacement piece (T2b) is fashioned from a Red Sea native known as apple ring or winter thorn acacia (*Faidherbia albida*). Overall, wood quality is excellent, with fine and tight grain. For example, Gawasis Type 2 planks are comparable in quality to cedar used in the four Dynasty 12 hulls from Dashur (Ward, 2000), and Gawasis Type 4 acacia planks exhibit fewer knots than the tamarisk Lisht timbers (Haldane, 1992; Ward, 2000).

### *Ship components*

Beam T32 was identified as a complete deck-level beam (Fig. 4) and the only transverse structural member (Type 1). The beam (3.29 m long, 0.28 m wide, and 0.18 m thick) was discovered with its rounded surface uppermost, parallel to the wall of the fossil-coral terrace, re-used to stabilize sediments between the entrances to Caves 2 and 3. Like the beams of Khufu and Dashur, T32 has ledges to receive deck-planking on its upper face. Its angled ends reflect hull-curvature and originally were fastened to hull-planks through square holes. The centre third of the cedar beam is worn down and eroded, suggesting a long use-life. It resembles beams on the Dashur boats in all these characteristics, but at 18 cm is twice as thick. Its rounded rather than squared lower surface probably helped prevent injury to people and objects in the hold (Ward, 2000: 87–8); the rectangular cross-section of Dashur beams is not surprising, since paired mortises on some beam edges, especially EM 4925, show the beams were hewn from re-used hull-planks.

Hull-planks (Type 2) resembled planks from other Egyptian watercraft, with comparable scantlings, unlocked mortise-and-tenon joints 13–15 cm deep, and damage from marine borers. There are no remains of lashing like the broad plaited straps at Abydos (Ward, 2003) or Lisht

 

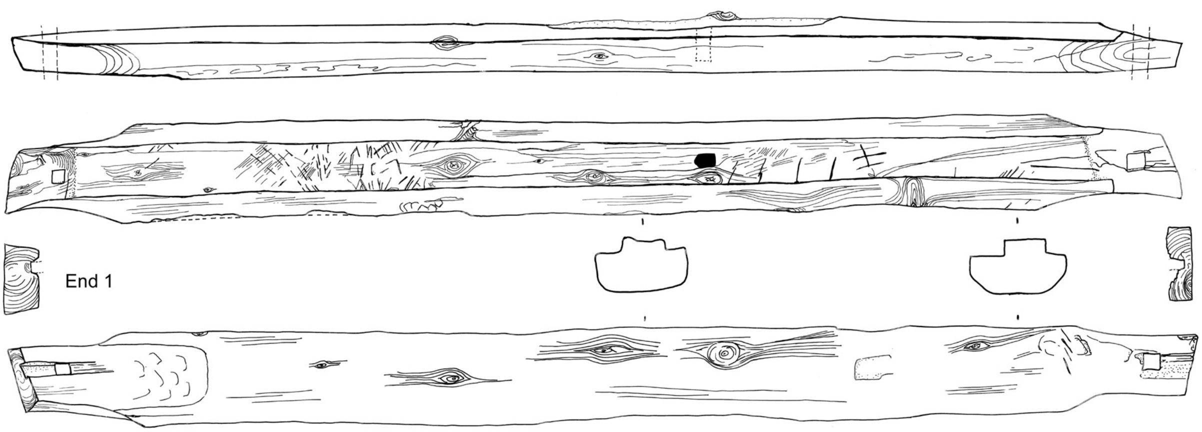


*Figure 4.* Beam T32 from Gawasis is worn away in its central portion, probably from the passage of seamen's feet. (C. Ward)

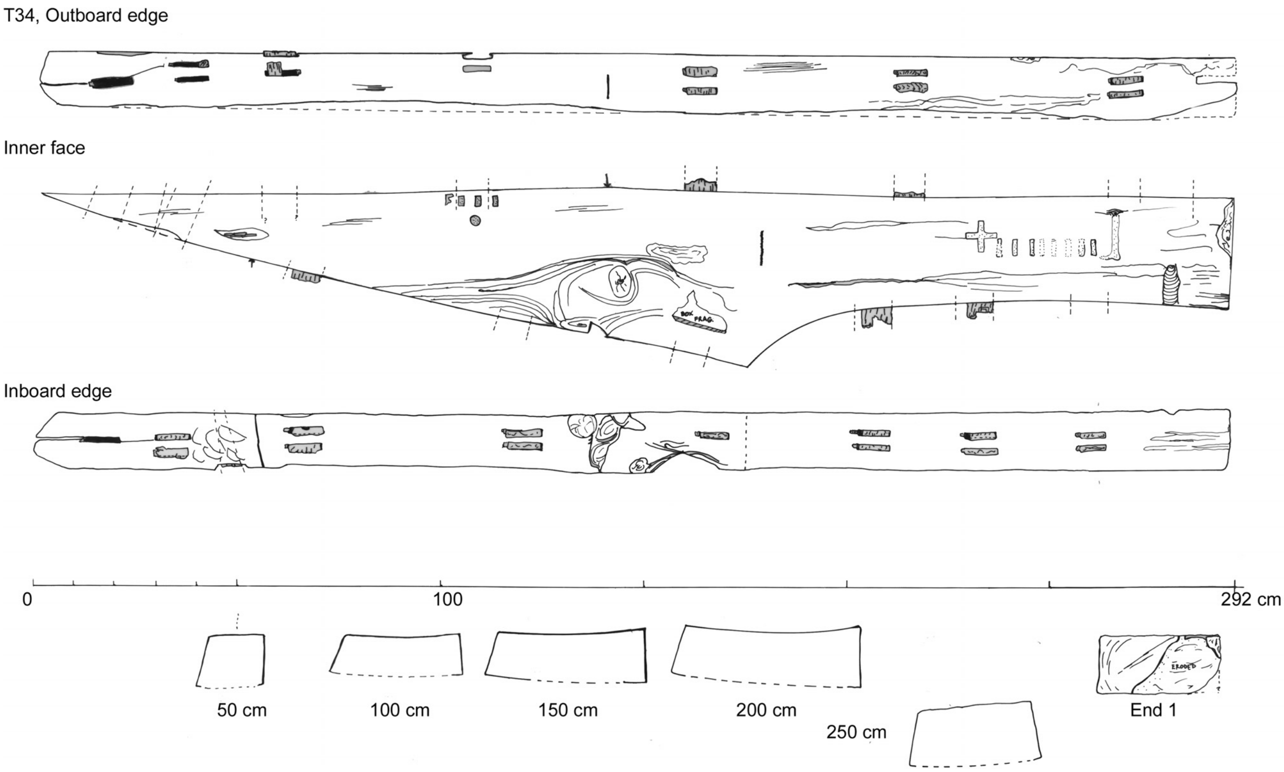


*Figure 5.* Hull-plank T34 preserves barnacles on its outer surface, copper strips used as ligatures, and an inscribed panel of marks on its inner surface. (C. Ward)

(Haldane, 1990; 1992) on any Type 2 planks. All 16 Type 2 planks are cedar or cedar-type (that is, with comparable fine and gross morphological characteristics such as colour, grain, and cell structure to planks identified as cedar by R. Gerisch). The most complete example is T34 from WG32, a knife-shaped plank familiar from rivercraft (2.93 m long, 46 cm wide, 15 cm thick) (Fig. 5). Plank T34 featured inscribed marks on its inner face and an L-shaped ligature-channel filled by copper-strip fragments (Fig. 6). Most planks in this category were short, thick segments of longer planks. Reworked planks were classified as Type 2 hull-planks if they exhibited an original thickness of 65 to 225 mm, in combination with deep mortise-and-tenon joints, and gribble, usually present on one wide face and plank edges.

The third timber type consists of planks only 75–90 cm long when complete, 20–35 cm wide, and less than 5 cm thick, with chamfered ends on

 


*Figure 6.* A 5-mm-deep recess protected copper strips at the narrow, pointed end of plank T34 from abrasion. (C. Ward)

one face (Fig. 7). Type 3 planks are similar in proportion and shape to deck-planks from the Dashur boats. Planks recorded by Ward from the four Dashur boats measure 52–68 cm long, up to 29 cm wide and 35 mm thick. Gawasis deck-planks are better finished, slightly larger in scale than most Dashur deck-planks, and at 10 cm, the angled portion of the lower face is longer than most chamfered ends of the Dashur deck-planks (usually 4–6 cm).

Most deck-planks identified by Gerisch are cedar; some are sycomore. Many of these planks, like those from Dashur, have traces of white plaster on at least one wide face. T13, of sycomore, bears a panel of inscribed marks in the centre of its lower face which may be related to a similar panel on hull-plank T34. Several deck-planks were probably fashioned from Type 2 ship-planks as they showed signs of marine-borer infestation on the lower face (T25). Numerous and deep adze marks and red paint over the damaged areas suggest these areas had been marked out for rot removal. At some point, examples like T25 and T26 were recycled into the contexts of discovery as ramp components or, like T22, wedged beneath hull-planks used in entrance walls to fill gaps created by hull-plank curvature.

Five Type 4 planks, some still joined when discovered (Fig. 8), illustrate a previously unrecorded mixed construction technology. At only 25–42 mm thick, Type 4 planks are thinner than hull-planks from any pharaonic rivercraft. Both mortise-and-tenon fastenings and pairs of ligatures for non-continuous stitching were used in Type 4 planks. Mortises for free tenons are about 5–6 cm deep, 1 cm thick, and 5 cm wide with a maximum tenon length of 12 cm, about half the length of similar fastenings in Type 2 hull-planks. Ligatures consist of holes 10–15 mm in diameter, paired across and along plank seams. Shallow grooves on the outer plank surface probably provided protection to the original stitching. The grooves are about 40–50 mm long, 12–15 mm wide, and 4 mm deep and extend from each hole to the plank edge. Although no cordage was visible in any of the grooves or holes at the time of excavation, short lengths of twisted copper strips 20 mm wide and 2 mm thick (Fig. 9) were found beneath the lower (inner) faces of several Type 4 planks. The strips are, however, wider than the grooves and are not necessarily associated with the planks.

A 3–4 cm wide black coating along plank seams (T13, T14, T41) probably represents a waterproofing agent on the outer planking surface. The coating has not been analyzed chemically. No petroleum-like odour, such as bitumen might produce, was detected when a small fragment was burnt. In 2005–06, all Type 4 planks were acacia or sycomore; in 2006–07, Zazzaro and Claire Calcagno recorded a Type 4 plank of cedar, reworked from a Type 2 hull-plank. Acacia and sycomore planks were less well preserved than the thicker Type 2 cedar examples. All examples excavated in 2005–06 had been recycled as ramps leading into the entrances to Cave 3 and Cave 4 (Fig. 1).

Auxiliary maritime equipment (Type 5) (Fig. 10) included two blades from steering oars T1 and T2 (Zazzaro, 2007: 151–3; Zazzaro, forthcoming), 1.89-m-long crutch or stanchion T44, and some small pieces such as knobs which may be oarlocks or pins. Half-round and round-sectioned sycomore fragments may represent the remains of oar looms, poles, spars or battens.

***Fastenings***

Fastenings offer critical information about construction techniques. At Gawasis, this category includes beam fastenings, free tenons of several sizes discovered in plank edges, on gallery floors, and in sediments both inside and outside caves; mortises, ligature channels and holes; pegs,

 

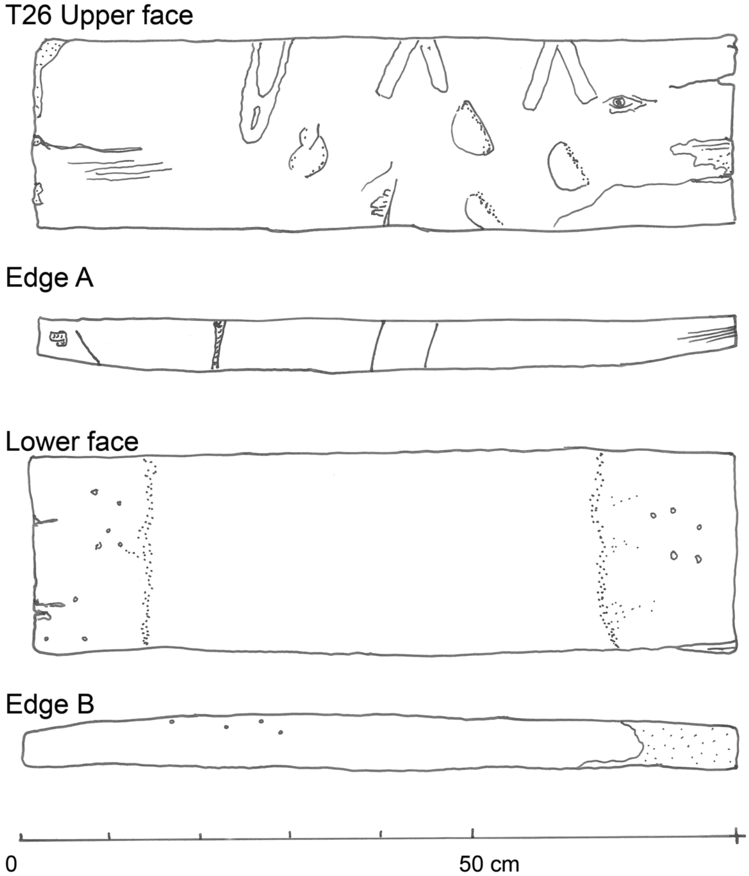


*Figure 7.* Deck-planks (Type 3) were re-used in ramps and architectural reinforcement at Gawasis, and were also manufactured from recycled hull-planks. (C. Ward)

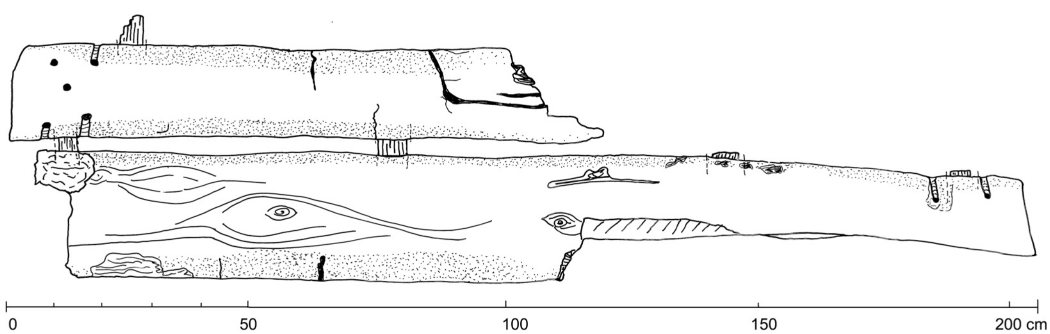


*Figure 8.* Type 4 planks T13 and T14 provide evidence of a previously-unattested shipbuilding technology which used thin planks, small mortise-and-tenon joints, and ligatures across plank seams like much later sewn-plank boats. (C. Ward)

shaved dowels, and copper strips. The nature of the site, with intensive discard and recycling processes, made it difficult to determine whether finds came from ships, ship equipment and fittings, boxes, or furniture remains, as all were represented. For example, a 4-cm-thick acacia plank-fragment with a faceted dowel (T50) and faceted dowel W67 (142 × 12 mm) were not part of a ship's hull, but illustrate common carpentry techniques. Similarly, pegs found in thin, broken planks and the remains of wooden boxes resemble loose pegs found in association with ship debitage but not present in hull-planks. In this section, only ship and boat fastenings are discussed.

A wood fastening familiar from rivercraft is present in the ends of beam T32 and in Type 2

 

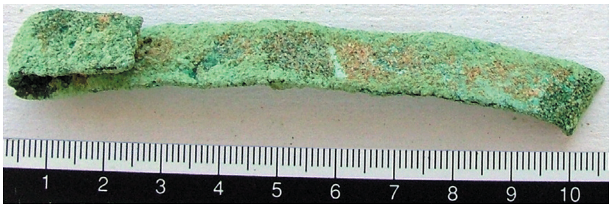


*Figure 9.* Fragments of copper strips were excavated near several planks at the site, but only the steering-oar blades and T34 had definite evidence of their use. (BU/UNO)

plank T18. Reisner (1913: 85) described a squared hole for securing beam-ends to sheer strakes on Dashur boat EM 4925 in the Cairo Egyptian Museum, and Ward documents similar channels (2000: 87) (Fig. 11) for Dashur boats at the Field Museum of Natural History and the Carnegie Museum of Natural History (CMNH). Cedar-type plank T18, probably split in half before its re-use to stabilize the entrance of Cave 2, is 134 cm long today and, near each end, has a hole that passes from one edge to the outer plank surface (Fig. 12). Nine closely-spaced mortise-and-tenon joints are present along its original edge. By analogy, this is probably the upper edge, into which shipwrights cut two holes about 95 cm apart. Only one hole is fully preserved; it measures 50 × 50 mm on the plank edge and 35 × 35 mm where it exits the plank's outer face. Holes of similar dimension in each end of beam T32 (Fig. 4) fitted over holes like these and permitted the shipbuilders to securely join transverse timbers to the hull. No fastening remains were present in the beam or plank holes, so the nature of the fastening is not certain. Wooden pegs fill the holes in planks on the Carnegie Dashur boat, and Reisner's description implies a wooden fastening.

Mortise-and-tenon fastenings in standard sizes and patterns joined Type 2 planks. In most

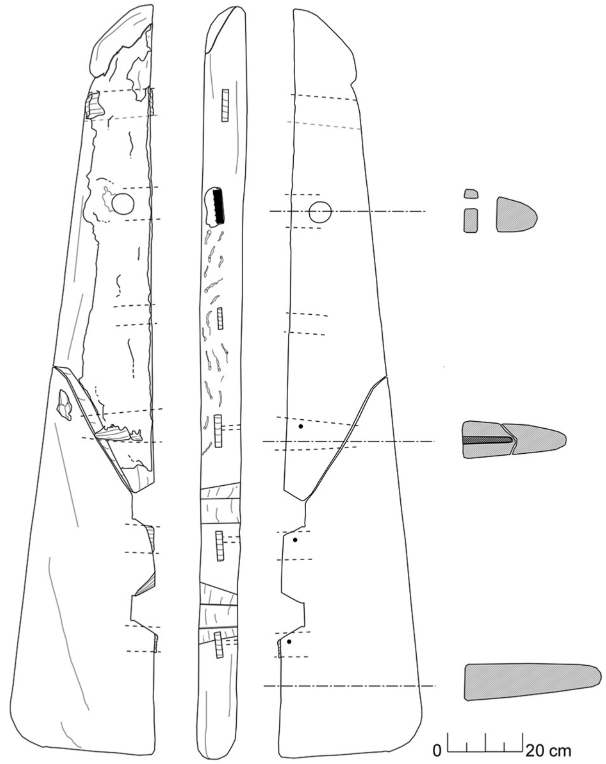


*Figure 10.* Auxiliary timbers include steering-oar blade T1. (C. Zazzaro)

Gawasis Type 2 planks, fastening spacing is between 40 and 60 cm measured centre-to-centre. Many Type 2 planks have a double row of mortise-and-tenon joints in the centre of plank edges (Fig. 5), a pattern familiar from paired or stacked joints in the disassembled Lisht planks (Haldane, 1992; Ward, 2000). Shipwrights used narrow-bladed chisels to cut trapezoidal mortises 80–95 mm wide and 15–18 mm thick into plank edges, extending about 12–15 cm into each plank. Tenon fragments remain in some mortises. Like the tenons at Lisht, most examples are sawn and

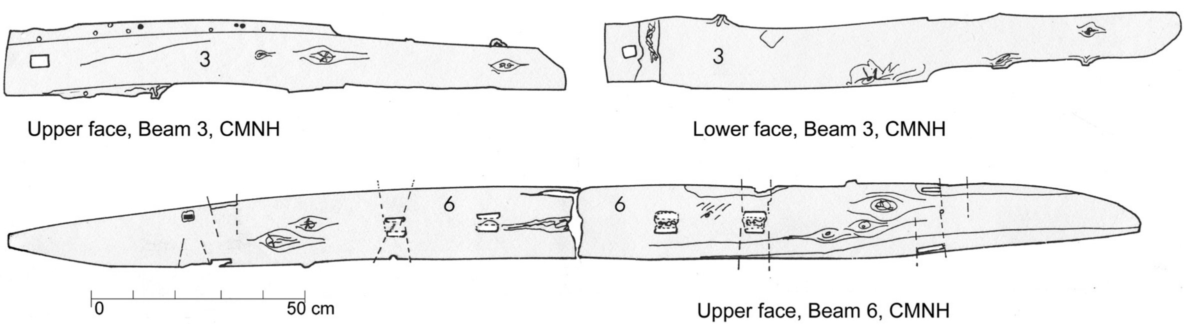


*Figure 11.* CMNH beam 4 is similar to Gawasis beam T32, but was manufactured from a recycled cedar hull-plank. One end of Beam 3 preserved its angled hole for a wooden peg to pin the beam to the sheer strake. (C. Ward)

 

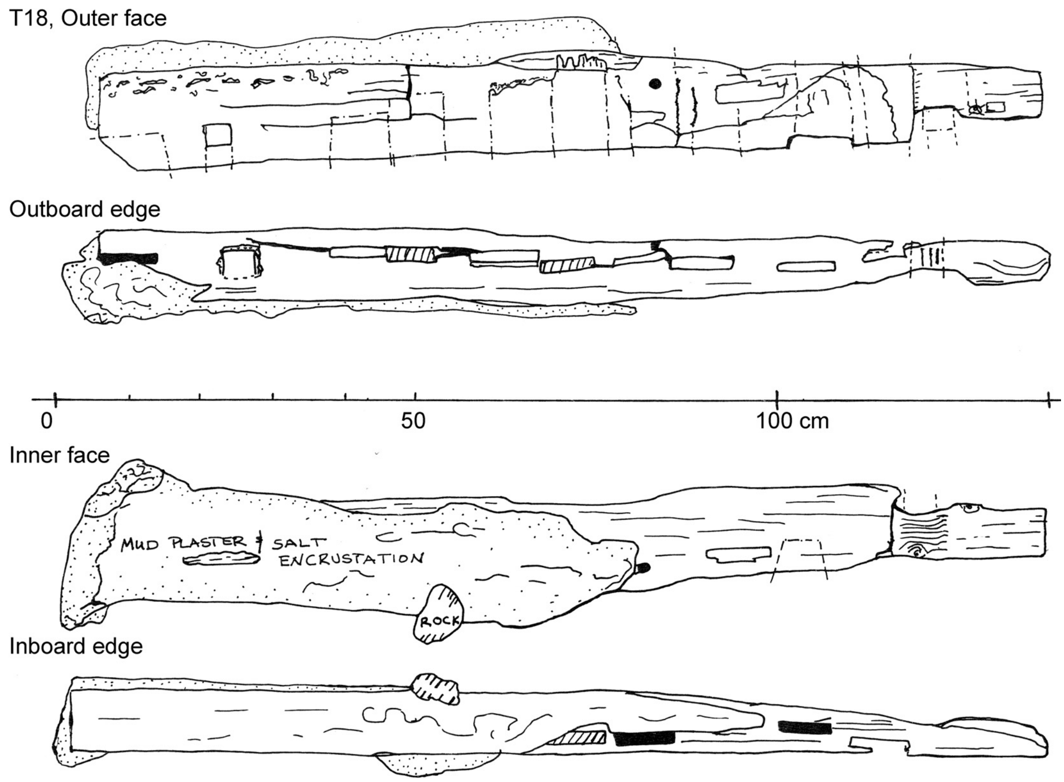


*Figure 12.* Sheer plank T18, re-used as a step foundation at the entrance to Cave 2, was in poor condition but retained beam-fastening holes as well as the remains of 12 mortise-and-tenon joints. (C. Ward)

chiselled across their centres, probably to permit breaking planks away from adjacent planks along plank seams. Occasionally tenons split lengthwise and occupy only half of the mortise today, but most fill or nearly fill the width and thickness of each mortise when present. All identified tenons are Nile acacia. Archaeologists recovered two Size III tenons (11 × 4 × 1 cm) from sediments which could also have been used in Type 4 planking. Some tenons found loose in archaeological sediments (Size I: 220–280 mm long, 40–60 mm wide and 12–20 mm thick) were probably intended for fastenings of this size.

The mortise-and-tenon joints are as a rule unlocked (not pegged). Three of 25 joints on T34 are the exception. The three mortises are within millimetres of the outer face, as opposed to being centrally located. In these joints, pegs 12–13 mm in diameter were located less than 20 mm from one edge of 85-mm-wide mortises (detailed observations of the outer face of T34 were made in the 2006–07 season by Zazzaro and Calcagno, and in the 2007–08 season by Zazzaro). Drilled holes of similar diameter were recorded on two tenon fragments from sediments at the site and in one mortise on Type 2 plank T18. Repairs like these probably fixed loose tenons in place. As is the case in other repairs to isolated joints on Egyptian craft (Ward, 2000: 98–100, 115, 119), the pegs simply fixed the tenon and did not pass through the plank's thickness. Mortise-and-tenon fastenings in thinner Type 4 planks are proportionally smaller and, at 60–75 cm, more widely spaced than those in Type 2 planks. At only 50–70 mm, mortises were one-third to one-half as deep as mortises in Type 2 planks and are only 55–60 mm wide and 10–13 mm thick. No paired fastenings were recorded. About half of Type 4 mortise-and-tenon joints are directly associated with a pair of ligature fastenings. Tenons found loose (Size II) are about 12 cm long.

Egyptian builders of rivercraft seem always to have relied on ligatures (Ward, 2004; 2006). Abydos Boat 10 planks were exclusively bound by lashing straps that crossed the hull (Ward, 2003). Similar straps, as well as individual ligatures, had extensive use in the Khufu ships (Lipke, 1984). A regular patterning of non-continuous stitching in L-shaped ligatures on timbers from Lisht, and possibly Dashur, has been documented. It is thus significant to note that only a single Type 2 hull-plank had a ligature channel; no other evidence for lashing was present in Type 2 hull-planks from 2004–06. The copper-strip lashing in plank T34 is described below.

Type 4 planks, in contrast, relied on binding as much as on wood-to-wood joining. On the outer face of a Type 4 plank, pairs of shallow (4-mm) grooves extend from plank edges to 12-mm-diameter holes through the plank (Fig. 8). The pairs of grooves sometimes flank a mortise-and-tenon joint in the plank edge or a hole drilled through the central part of the plank. Ligature holes are at slightly different distances from the plank edge, probably to avoid potential weakness along a single grain line, and one of each pair of grooves curves slightly. No trace of cordage or lashing remained in any hole or groove. These pairs of holes, almost certainly for lashing frames to planking, recall many similar examples, from Omani *boum*s to ship-planks re-used in medieval burials at nearby Quseir (Blue, 2006). The mixture of mortise-and-tenon joints with lashed frames also recalls some aspects of the 7th-century-BC Phoenician ship Mazarron I (Negueruela *et al.*, 1995). T8, a Type 3 deck-plank, has two pairs of opposing ligatures in the same pattern but lacks mortise-and-tenon fastenings.

Gawasis provides direct evidence of metal fastenings in twisted and bent remnants of copper-alloy strips of a constant width (Childs, 2007). Zazzaro (2007: 152) notes that both Reisner and Boreaux believed dark bands on painted model steering-oars represented metal strips for fastening, and points out that the bands appear in roughly the same location as copper-strip remains on Gawasis blades T1 and T2. Copper is rare on Egyptian watercraft, but was used in limited quantities in the superstructure of the excavated Khufu ship for a door latch, for example (Lipke, 1984), and to a greater extent in the unexcavated Khufu ship (Ward, 2000: 65–8). Reisner (1913: 85) also suggested that butt joints on the Dashur boat bulwarks were secured by metal or leather strips, a technique also known from coffin carpentry.

Four fragments of copper strips (*c.*150 × 20 mm with a thickness of 2–3 mm) remain in a single channel in the narrow, pointed end of hull-plank T34 (Figs 5 and 13). We suggest that a single long strip was threaded repeatedly through a channel in the tip of T34 and another in the plank below it. A wooden wedge compressed the strips and still fills the channel. Subsequent examination of the channel by Zazzaro revealed what appeared to be rope fragments between the copper strips and the lower edge of the channel (Fig. 13). The channel and recess on the outer plank-face strongly resemble ligatures that connect the central strake and the ends of the second strakes low in the hull of the Khufu ship (Ward, 2000: 49) in that the fastening material is exposed on the outer face of the plank, but protected from abrasion by being set into the recess. Other metal fastening remains at Gawasis include a twisted copper fragment (35 × 18 mm) found with a potsherd beneath ligature holes at the west end of Type 4 plank T13. It resembles a 4 × 2 cm fragment from Cave 2 sediments and an isolated 10 × 2 cm strap found beside T60, a 2-cm-thick plank with dovetail-shaped ends (Type 5, other).

*Figure 13.* Close examination of the copper strips in the T34 ligature revealed degraded rope fragments amongst them, like these from a fragment found outside Cave 2. (C. Zazzaro)

We identified eight loose dovetail-tenon fragments (Fig. 14) in 2005–06, one near the Cave 2 anchors, two near ramps leading to the Cave 3 entrance, and five in shell-and-wood debris from plank-cleaning activities on the floor of Cave 3. No planks or plank-fragments excavated in 2004–06 retained any trace of mortises to hold dovetail tenons, but a probable keel-plank segment later excavated by Zazzaro and Calcagno had two dovetail-shaped mortises on its upper surface in positions similar to those Ward recorded on planks in the central strakes of Dashur boats (Ward, 2000: fig. 36). All dovetail tenon fragments are acacia-type wood, and each displays tool-marks related to manufacture and to disposal. Each tenon was vigorously chiselled or sawn into two or more pieces near its narrowest point, and pry-marks made by chisels suggest

 

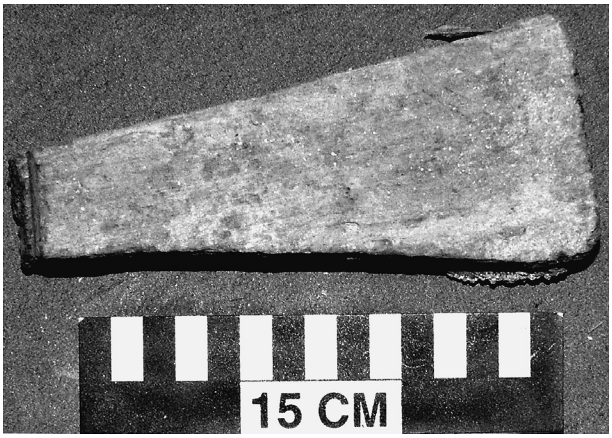


*Figure 14.* Dovetail-tenon fragments were chopped apart by chisels near their narrow midpoints. (C. Ward)

that wherever the Egyptians had used the tenons, they fitted tightly. Original dovetail-tenon dimensions were probably in the range of 220–300 mm long, 35–40 mm thick, and 65–70 mm at their widest point, narrowing to 30–35 mm. The tenons are flat, that is, they do not curve or change angles along their length like the modern dovetail tenons in the Dashur boats, which were forced into re-cut or new mortises (Ward, 2000: fig. 42).

Architectural builders and carpenters commonly used dovetail tenons to secure seams in ancient Egypt as early as the 4th Dynasty, and at Gawasis there are dovetail-shaped mortises in some stone anchors re-used at cave entrances (Zazzaro, 2007: 153–5). Late-19th-century re-assemblers of the Dashur boats cut dovetail fastenings into its planks to replace decayed lashing mortises (Ward, 2000: 93–4; Ward, 2004), but their presence is not otherwise recorded in the hulls of extant ancient Egyptian watercraft. Dovetail tenons and crosspieces with dovetail ends like plank T60 are present in the sledge accompanying the Dashur boat-burials (Reisner, 1913: 88). Until January 2006, the use of dovetail tenons by Egyptians for hull-plank fastenings was not attested.

***Tools, surface treatments, incised marks***

In addition to recording dimensions, wood characteristics and fastening patterns for each timber, Ward also examined all wood fragments for tool-marks and other features to identify activity areas and patterns. Evaluation of tool-marks showed that the expected saws, adzes, chisels, and probably polishers were in use during both the construction and recycling processes. A few drilled holes imply use of the bow drill, and in a few cases workers used axes to reduce plank-length as on T33, a 450-mm-wide and 225-mm-thick cedar plank used to reinforce the entrance to Cave 3.

Ward noted that original shaping included careful finishing of most timbers of every type, resulting in few tool-marks visible to the eye. A few score-marks, shallow dubbing-marks of an adze with a blade only a few centimetres wide or even smaller, and crushing caused by a chisel-handle on one edge of mortises, fall into this category. Abundant saw-marks on wide faces of Type 4 acacia planks and adze-marks on the sharply-bevelled tips of tenons are the only examples of original woodworking which left significant tool-marks.

In contrast, larger tools used to hack and gouge planks and fastenings may be associated with reworking of planks. Tool-marks considered to be indicative of re-working include saw-marks at plank-ends, deep and wide gouges made by adzes, chisel-marks and pry-marks. A more ephemeral tool of the shipwright stands out, red paint on finished surfaces. Red paint is present on many of the timbers which also bear evidence of shipworms, and on perhaps 5% of the wood debitage evaluated in 2005–06. Ward believes that the paint was used to mark areas that needed to be removed, perhaps in accordance with the Old Kingdom word *ßd-(m-)dßr*, translated by John Darnell (1984) as 'remove the red'. Red paint is present only in areas of extensive re-working or damage.

Some Gawasis planks also bear incised marks that we suggest may relate to construction methods (Fig. 15). Two hull-planks (T18, T34) and at least one Type 3 deck-plank (T15, and possibly T11) bear panels of chiselled marks which include at least one standard hieroglyph and what seem to be notational marks. Because some of the notational-type marks extend to the plank's original edge, we suggest they were intended to meet up with comparable marks on an adjacent plank. Such a system is logical in considering how ships built at a Nile shipyard might easily be reassembled on the Red Sea shore, and has a precedent in the marking system on Khufu hull-planks and battens (Nour *et al.*, 1960: 8).

## Other maritime artefacts

Cave 5 is 19 m long and is visible from Cave 2 where the wall separating the two rooms collapsed. A

 

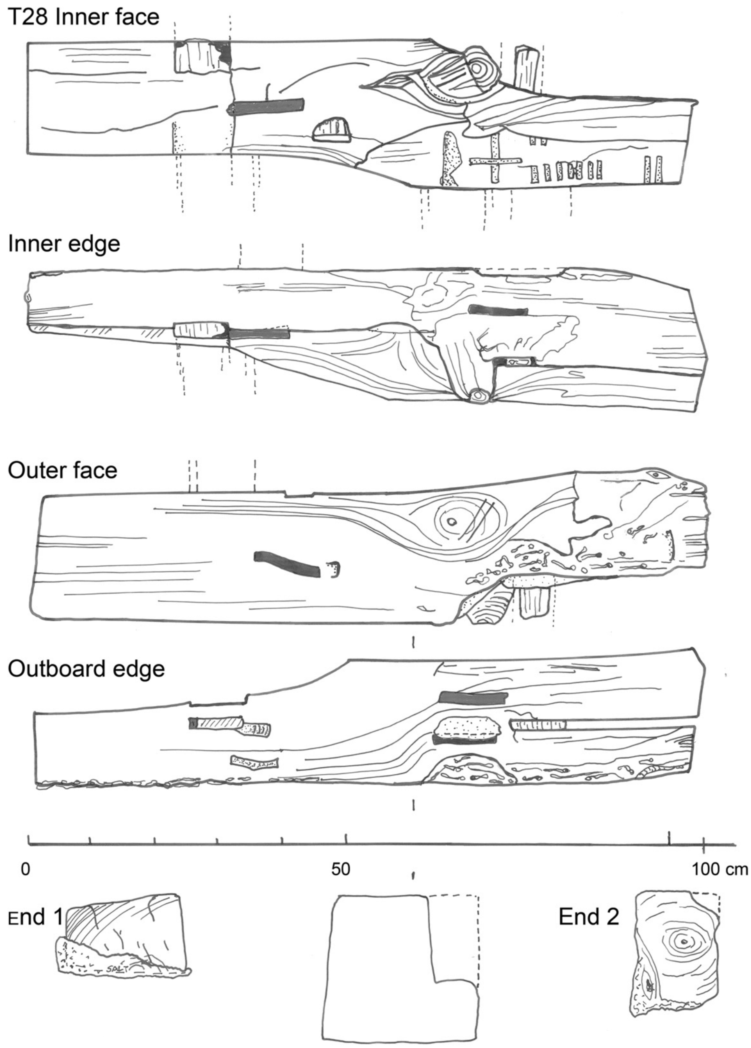


*Figure 15.* Chiselled tally-type marks and simple signs such as the crossed bars (used to indicate the unit of measure for a palm), here on Type 2 plank T28, probably signified plank location within the hull. (C. Ward)

mound of Aeolian sand extends 5 m into the cave from its entrance, where some fragments of wooden boxes were visible. About 30 large coils of rope, each about 1 m long and 60 cm wide, cover the central and inner part of the cave (Fig. 1). Loops about 1 m long are tightly wrapped perpendicularly by 15–18 turns, suggesting each coil is at least 20–30 m long. Zazzaro's examination of two samples identifies them as C5 type with fibres 3–7 mm wide, twisted in three yarns to create strands of 30 or 35 mm diameter. Tangles and knots visible on the surface of Cave 5 include a sort of diamond knot at the end of a rope. Abundant cordage remains were excavated throughout the site, including a number of other knots (Zazzaro, 2007: 192–5).

A number of textile remains were excavated, including more than 40 fragments studied by Zazzaro (2007: 189–90). Textile fragment L9 had wood splinters adhering to it, and eight textile fragments found inside or near 21 wooden boxes outside Cave 5 probably represent fragments of lining for the boxes and are not further considered here. General morphological characteristics such as the natural rotation of the fibre (S-spun), and a characteristic sheen, suggest that all textile samples were flax/linen. Textile finds are characterized by a loose weave with an equal number of single threads (S-spun) in both warp and weft directions. Most examples were made by passing alternately one weft over and under alternating warp threads, a common pharaonic-period technique. A very few textile fragments were created by alternating two wefts over and under one warp, or alternating two wefts over and under two warps. At Gawasis, two small woven fragments are characterized by a tight weave of thread, and an unequal number of warp and weft threads (L1 and L2). In these two cases, the number of warp threads exceeds the number of weft threads.

Two finds are of particular interest. L11, a 65-cm-long linen fragment, was found in the east wall structure of the Entrance Corridor of Cave 2. It had a simple hem (Vogelsang-Eastwood, 2000: 283, 111.11a), 1 cm wide, and folded over twice before it was reinforced by sewing 5 weft by 5 weft. The heavy construction and L11's association with other artefacts in the entrance suggests it may have been ship's equipment, possibly a sail, recycled in the wall construction. The earliest fragments of identifiable sails date to the Roman period in Egypt (Wild and Wild, 2001) but do not include hems. Another textile fragment (L10, 22–23 cm long) from Cave 2 was partially impregnated with a black substance. At other sites, jar-sealings of resin were preserved as a dark residue (Jones, 2002: 337–8). L10 was both stretched and compressed before it was inserted into a thin crack. Its association with a large concentration of ship-timbers prompts us to propose that it was used not as a jar-sealing but perhaps to improve watertightness by stopping a seam.

## Analysis

After more than a century of having only rivercraft to study, maritime specialists now have two new direct sources of evidence for seafaring on the Red Sea. At Ayn Sokhna near Suez, French excavations have revealed charred timbers re-used in architectural contexts in galleries similar to those at Gawasis (Mathieu, 2004: 690–94, el-Raziq *et al.*, 2006). Small mortise-and-tenon fastenings and lashing channels suggest the planks, 10 cm thick and up to 23 cm wide, probably belonged to a small ship that may date to the Middle Kingdom. Patrice Pomey is documenting the discovery.

Inscriptions found on limestone anchors arranged in shrines provide an outline of Red Sea travel for the Egyptians in the Middle Kingdom (Sayed, 1978; 1980; 1983). Ships were built at a Nile shipyard at Koptos and then disassembled for transport across the Eastern Desert. Assembly of the ships took place at the Red Sea, probably also at Gawasis or possibly further north as several authors have suggested (Meeks, 2002: 319–30; Fabre, 2004: 76–81), although the inscriptions at Gawasis support its service in both departure and return trips. More than 3000 men participated in such expeditions according to inscriptions on anchor shrines and in the Wadi Hammamat (Sayed, 1983). There is, however, no independent physical evidence for ship-assembly at Gawasis, and frankly, it is hard to imagine what might indicate ship-assembly rather than disassembly.

At Gawasis, ship-breaking was the primary activity attested by archaeological evidence as Sayed (1977; 1983) proposed after his study of inscriptions and the remains of tools and ship-planks, among other finds. The archaeologists working inside and outside Caves 2, 3, and 4 recovered ramps made of used ship-timbers, extensive deposits of chipped and shipworm-infested wood fragments, fastenings cut and broken by sharp-edged tools, and, in Cave 3, marine shell mixed with wood fragments degraded by marine borers which testify to the trimming and reworking of planks. The wood debitage came from planks that resemble hull components recorded in 2005–06.

We suggest that after a successful voyage, ships anchored on the lagoon's edge below the fossil-coral reef. As the cargo was unloaded, shipwrights inspected the hulls, marking damaged timbers with red paint. Workers dismantled the hulls by prying seams apart and sawing or chiselling through tenons, as is attested for Lisht hull-planks (Haldane, 1992). Other workers probably followed behind them, leaving telltale breaks in tenons while pulling planks off the ship from the outside. Men carried the timbers into the hand-carved rooms, keeping secure footing over the sand outside by using planked ramps reinforced with mudbricks.

Inside Cave 2, walkways made of short and cut-up planks *c.*80–100 cm long made a level surface for those who worked in Room 1 and in the 19 × 4 m working space beyond it. There, workers cleaned individual planks, preparing them for storage, discard, or recycling in architectural features at Gawasis, or even as fuel for cooking or warmth. Rainer Gerisch identified charcoal samples from non-native species *Cedrus libani, Pinus* sp., *Quercus* sp., and even *Dalbergia melanoxylon* (Egyptian ebony). It is also likely that a large number of cleaned timbers were sent back to shipyards or carpentry shops on the Nile for re-use.

 

At Gawasis, ship-timbers and associated debris provide direct evidence for seafaring in complex watercraft built with standard Egyptian construction technologies. The Middle Kingdom craft buried at Dashur, and disassembled timbers from Lisht (*c.*1850 and 1950 BC) (Haldane, 1992; Ward, 2000; 2004) provide the best parallels for most of the Gawasis finds. The steering-oar blades, however, are more similar to early New Kingdom examples (Zazzaro, 2007: 150–53). Features of hull-components revealed strong links to Middle Kingdom river-boat construction technology as illustrated in the Dashur vessels and the recycled working-boat planks from Lisht, but new or slightly different patterns and priorities are visible in Wadi Gawasis timbers. Like all other ancient Egyptian watercraft, the seagoing ships depended on sizeable, paired mortise-and-tenon fastenings without locking pegs, unlike later Mediterranean Bronze Age and Classical ships. The remains of thinner, less-rigidly-fastened planks with waterproofed seams that belonged to a very early sewn, seagoing boat serve as a reminder of the diversity of watercraft present in ancient Egypt.

While planks and other timbers are similar in design and proportion to Dashur and Lisht components, examples from Gawasis are typically more robust. Deck-planks, for example, are about 15% larger than those Ward recorded on the four Dashur boats. Plank thickness is perhaps the most obvious example of this difference as Type 2 hull-planks are up to 22 cm thick as compared to 13–14 cm maximum thickness of the planks in the *c.*10-m-long Dashur hulls or 15–17 cm for Lisht timbers. The additional thickness probably addressed several concerns. The planks had to accommodate paired mortise-and-tenon joints placed one above the other. In most cases, the fastenings were evenly spaced in the plank's thickness (see detail in Fig. 5), and builders left 5 cm between the outer plank face and the outboard tenon. The practical nature of this design reflects evidence of marine borers in only the outer 5 cm of hull-planks. Although the Egyptians understood the use of resin to protect wood from decay in many contexts, there are no traces of an exterior coating on any Type 2 hull-plank or debris from a Type 2 plank. The Egyptians may have relied on the resinous nature of cedar to protect the ship, but gribble and shells in some tenons testify to the type of damage the shipwrights hoped to avoid. A few fragmentary planks originally 6 cm thick were so riddled with borer tunnels that they looked like sponges.

In addition to providing room for fastenings and shipworm destruction, the thick planks also helped stiffen the hull. Because the planks were carried more than 150 km along desert routes by men and animals, most were probably less than 4 m long. Beams, masts, and spars would have been the longest timbers transported. Beam T32 has the same overall design as beams from the Dashur boats, but it is about 30% larger at 3.29 m long, 28 cm wide, and 18 cm thick (Fig. 4). As a comparison, the midships beam for the CMNH boat is 2.22 m long, 18 cm wide, and only 9 cm thick. The remains of mortise-and-tenon fastenings on the edges of CMNH Dashur Beam 4 suggest that it, like several beams in the mid-section of EM 4925 from Dashur, is made of a re-used hull-plank from a larger cedar ship.

The recycling of cedar planks as beams for the Dashur boats hints at why ship-breaking at Gawasis included extensive cleaning of shells and gribble. Unless planks were to be recycled in other vessels or as coffins, furniture or boxes, it is hard to explain the effort expended to strip planks of barnacles and rotten wood. Although the planks would no longer be serviceable in their original role on a seagoing ship, it is clear they were modified for other purposes. Both archaeological and textual evidence, in the form of timbers on the Dashur boats and early New Kingdom dockyard records (Glanville, 1930; 1932), document the re-use of ship-timbers in other watercraft.

It is likely that Type 4 planks exemplify small-craft construction as they are thinner, made of local wood, have small mortise-and-tenon joints, and have no marine-borer damage from long-term immersion in sea-water. The mid-plank holes probably served to attach light frames. Use of a sealant along outer plank edges, with no additional waterproofing material or indication of caulking between planks, marks the earliest evidence for this practice. It is tempting to consider these planks and speculate about possible links between them and the ship's boat at the southern end of the Hatshepsut reliefs, a boat carried on deck or, perhaps like later Basque whalers, even in pieces for assembly once the expedition neared Punt. Auxiliary components and maritime equipment such as the crutch, steering-oar blades, and possible oar-pins help to elaborate aspects of actual voyaging and provide insight into the dispersal and disposal of wood elements. Zazzaro's study of the blades (forthcoming) provides a detailed analysis of the physical construction of steering-gear as well as well-grounded perspectives on how to use the blades to gain a better understanding of Egyptian seafaring.

Cordage recovered in Cave 2 and stored in coils in Cave 5 will lead to greater understanding of standing and running rigging for seagoing ships. In the 2nd millennium BC, rope manufacture required a significant investment of resources. Janssen's (1975: 175) study of the New Kingdom (19th dynasty) Workman's Village near Deir el Bahri notes that for a silver *deben*, one could purchase two fine cattle or a coil of ship's rope 100 cubits (45–50 m) long. No other stores of usable equipment or foodstuffs have been located at Gawasis, so the find is unusual. Why the Egyptians left the rope behind is unknown, but it may be that its maritime value was diminished by several months of use or perhaps an insufficient number of bearers was available to return it to the Nile. If this is so, the old rope retained value for tasks related to anticipated future operations on land or at sea.

## Conclusion

At Gawasis, intensive activity related to ship-breaking is attested by marine incrustations, destruction by shipworms, ship-timbers recycled as architectural elements, and wood debris from ship-components on both the western and southern face of the fossil-coral terrace. Like other rare artefacts discovered by archaeologists working at Gawasis, the maritime finds contribute to a broader understanding not only of the role of shipbuilding technology and achievement, but of the vast administrative and bureaucratic nature of ancient Egyptian relations with the world beyond its borders. Studying these forgotten ship-planks and equipment—the products of shipyards operating under a philosophy not too far removed from an assembly line—at the end of their very long life informs us not only about ship-construction technology and shipbuilders, but also about the integration of watercraft as economic tools in ancient Egypt.

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