



Building pharaoh's ships: Cedar, incense and sailing the Great Green

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For more than a century, scholars have argued about whether, when, how and in what sort of ships the ancient Egyptians went to sea. Textual references to seafaring are scarce and often provide few details, but new finds in the past decade dramatically change this picture. Recent discoveries of the remains of seagoing ships at the pharaonic anchorages of Wadi Gawasis and Ayn Sokhna provide the first physical evidence of massively built cedar ships that were used to conduct the business of the Egyptian empire at sea. Their cargoes are indicated by textual references, often supported by archaeological evidence as well, and the impact of seafaring on Egyptian society is reflected in areas as diverse as gold jewellery styles and an effort to secure the throne by sending an expedition to acquire incense and other exotic products from lands bordering the southern Red Sea.

In this paper, Egypt is considered in its role as a seafaring nation influencing and interacting with other groups through the perspective of the major tool required: the seagoing ship. The analysis of ancient Egyptian ship remains permits us to explore connections between ceremonial and working craft intended for a riverine environment and to apply new knowledge for determining the underlying principles and practices that guided this advanced technology—a technology that permitted the Egyptians to sail round-trip journeys of more than 2,000km regularly beginning in the Old Kingdom (Wilkinson 2000; el-Awady 2009).

Indirect evidence for seafaring

The unique nature of urban civilisation in Egypt contributed to an elaborate hierarchical society which demonstrated status and wealth in a number of ways, including significant resources devoted to burial processes and goods, such as full-size watercraft, texts naming and describing watercraft and their roles, representations of many different types of vessels in paintings and reliefs, and models of ships and boats and the people who used them (Ward 2000; Faulkner 1941; Landström 1970; Reisner 1913).

Ancient Egyptian burial and religious practice in an arid environment resulted in the preservation of thousands of images and models showing a wide variety of river craft sailing upstream with the wind (in a southerly direction) and moving with oars and the current downstream (to the north), but it is the preservation of a number of early watercraft that defines precisely how these vessels were built for river use. From the earliest planked wooden boats known in the world found at Abydos (c. 3000 BC) through to a Persian-period work boat (c. 500 BC), Egyptian vessels exhibit similarities and a consistent philosophical approach to creating a shell of thick and sturdy planks, fastened along their edges, with beams across the hull at deck level but few frames (Ward 2004; 2006).

The arid environment also preserved early achievements in woodworking in cemeteries

of Predynastic and Early Dynastic settlements. By the mid-4th millennium BC, carpenters had developed skills and tools to produce planks of regular thickness measuring up to 2m long and 2cm thick and began to develop a range of fastening techniques that we consider characteristic of Egyptian woodworking (Ward 2000, 25–38; 2004, 13–14). Early examples of furniture from chair and bed legs to boxes and coffins also preserve a record of rapidly expanding expertise (Petrie, Wainright and Gardiner 1913; Killen 1980).

Fastenings included both lashed or sewn connections between components and wood-to-wood joints such as mortise-and-tenon fastenings in which slips of wood called tenons fit tightly in mortises (slots) cut into edges of adjacent planks to fasten them together (Fig. 1). But from the beginning, some techniques regularly applied to furniture building and box or coffin construction were avoided in the construction of boat and ship hulls. The practice of locking the common mortise-and-tenon fastening in place by pegs on either side of the plank seam was particularly avoided (Fig. 2). There are a few exceptions documented in the hundreds of ancient Egyptian hull components examined by the author, but these examples tended to be specifically for the repair of loose fastenings or the fixing of tenons in fastenings too close to a plank edge. This feature is significant in identifying the indigenous nature of Egyptian boat and shipbuilding.

It is the Egyptian practice of using thick planks (the thinnest Egyptian riverboat planks are 6cm thick) held together with deep, unlocked mortise-and-tenon fastenings about a cubit apart, with very few framing elements, that is easily identifiable. Mediterranean ships, from the oldest yet excavated at Uluburun (c. 1300 BC) to the last plank-first hulls, relied on thinner planks. Up until the late Roman period, these planks were held together by mortise-and-tenon fastenings placed so closely together that they sometimes overlapped, and pegs locked every tenon in place. Locked fastenings help prevent longitudinal slippage along plank seams; the Egyptians developed plank shapes that limited long, straight runs of planking to achieve the same goal but which allow disassembly and reassembly of hull components without damage (Fig. 3) (Ward 2000, 126–28). Similar patterns are present in planking and other components of both seagoing and river vessels, so Egyptian-built craft are recognisably different from those of other cultures and demonstrate consistency in philosophy and detail over a 2,500-year span.

Beyond the indirect evidence offered by representations and epigraphy, full-sized river craft were part of monuments or burials at Abydos (fourteen boats in mud-brick boat graves from the reign of Aha, Dynasty 1; Ward 2006); at Giza (two disassembled royal ships in stone-cut pits and scraps of two complete vessels in boat-shaped pits outside Khufu's pyramid; Lipke 1984; Ward 2000); and at Dashur (four 10m-long boats outside the pyramid of Senwosret III; Ward 2000; 2004). The remains of disassembled vessels were excavated in contexts of reuse at the Middle Kingdom pyramid sites of Lisht (Haldane 1992; Ward 2000) and Lahun (Petrie, Brunton and Murray 1923, pls 8, 13, 15, 25) on the Nile, and disassembled ship timbers from the Middle Kingdom have been identified in storage galleries at Ayn Sokhna on the Red Sea (Tallet 2012; Pomey in press) and in contexts of reuse and storage at Mersa/Wadi Gawasis farther to the south near Safaga. It is these vessels and timbers that constitute the physical evidence for the indigenous and unique methods of Egyptian boat and ship construction for the Nile and for seagoing ships (Ward 2004). This evidence was used to construct a full-

scale reconstruction of an Egyptian ship, built and sailed in 2008–2009 (Ward and Zazzaro 2010; Ward, Couser and Vosmer 2007; Couser, Ward and Vosmer 2009; Ward, Couser, Vann, Vosmer and M. A. el-Maguid, in press).

Recently, the robust scholarly debate regarding the meaning of the very words used to describe the sea, not to mention the routes, harbours and products, has shifted. New data and analyses change the basic question from ‘did the Egyptians go to sea’ to ‘how often and how far did the Egyptians sail at sea.’ To find the waters called ‘The Great Green’ (*Wadjat Wer*) by the Egyptians, we must look north to the Mediterranean and east to the Red Sea as they once did to find similar seasonal winds and current patterns to move ships along distant shores. No ancient Egyptian shipwrecks have been discovered, although a number of underwater surveys have sought them out (e.g., Haldane 1996), so terrestrial finds of ship remains at port sites are critical.

An awareness of these finds has informed some epigraphic approaches to interpreting texts as well. Marcus, for example, uses archaeological evidence to propose a new reading of the Mit Rahina inscription carved to commemorate year 3 of Amenemhet II (2007). The record of Amenemhet’s third regnal year included a voyage to Sinai for turquoise, copper and even ‘sea stars,’ probably conducted by vessels that departed Ayn Sokhna and crossed the Gulf of Suez in a day’s sail. The timbers of those vessels resemble Middle Kingdom examples of boat planks from the Dashur boats, and like them, were carved from cedar of Lebanon (*Cedrus libani*) (Pomey, in press).

Military actions, tribute and trade with peoples controlling the coastal zones of modern Lebanon and Syria provided the ancient Egyptians with cedar, a conifer that produces long, straight timber. This lightweight, durable and strongly scented resinous wood was valued for ships, furniture, statues, coffins and other finely crafted objects in the ancient world. The Egyptians had a nearly insatiable appetite for it. Marcus has attempted to quantify the minimum amount of wood (and other spoils of war) loaded on Egyptian ships after a military excursion to the Levant by Amenemhet in year 3 (2007).

Cedar only grows above 1,700m in elevation and was harvested from forests on mountains near the sea and transported as trimmed, roughly squared logs. Transported on ships to Egypt, cedar intended for ship construction was converted to ceremonial craft like those at Dashur and Giza, or perhaps was sent to a royal shipyard such as the one at Quft (ancient Koptos) (Simpson 1965; Glanville 1935).

The shipyard at Quft is mentioned in a Middle Kingdom inscription describing the construction of ships at the yard on the Nile by one brother and another brother who built them (again) at Gawasis. The inscription was discovered in the 1970s by Prof Abdel Monem Sayed of the University of Alexandria, who also discovered limestone anchors, sawn-off ends of mortised ship planks made of cedar and ceramics typical of the early Middle Kingdom (el-Sayed 1977; 1978; 1980; 1983).

Since 2000, discoveries of ship remains at Gawasis and other ancient Red Sea port sites have expanded our core knowledge of when and how ships and boats moved people, goods and ideas within and beyond Egypt’s borders. Finds at Gawasis contribute new information about the vessels that played a vital role in supplying incense and other non-local products to the upper ranks of ancient Egyptian culture.

Incense is the featured goal of a voyage to Punt commemorated in reliefs on the pharaoh Hatshepsut's mortuary temple at Deir el-Bahri (Fig. 4). This representation of five ships sailing south to Punt and north, more heavily laden, with the products of Punt, provided the principal evidence for ancient Egyptian seafaring on the Red Sea until excavations at Gawasis uncovered a vast frontier complex for staging round-trip voyages to Punt, probably beginning by the late Old Kingdom, c. 2494–2345 BC (Dynasty 5), but used predominately in the Middle Kingdom (Bard and Fattovich 2007).

The port of the pharaohs

Beginning in January 2005, excavations at Gawasis under the direction of Kathryn Bard (Boston University) and Rodolfo Fattovich (University of Naples 'L'Orientale') revealed complete and reworked ship timbers as well as thousands of wood fragments. These fragments were created when ancient workers disassembled ships whose shipworm-riddled timbers suggest substantial sea journeys. Mersa Gawasis is the modern name of the ancient pharaonic port of *Sanw* on the Red Sea, about 24km (14mi) south of Safaga. It is the mouth of Wadi Gawasis, now silted in, but once a protected lagoon.

When the ancient Egyptians began to use the site near the end of the 3rd millennium, a brackish lagoon lined with mangroves and up to 10m deep extended about a kilometer from the sea into this protected area. Explorations at Gawasis identified long, hand-cut galleries carved into an uplifted fossil coral reef along an ancient lagoon shore (Bard and Fattovich 2007). The galleries gave them dry and climate-controlled spaces for work, rest and storage of materials. Primary use of the site and its major construction features date to the Middle Kingdom (2022–1650 BC). Most artefacts are dated to Dynasty 12, but slightly earlier and later expeditions are also represented.

Hieroglyphic texts carved on commemorative stelae at the site, administratively oriented hieratic texts on ostraka and archaeological evidence from storage jars to donkey jaws identify activities that took place here under state-level control (Bard and Fattovich 2010). Much of the maritime assemblage dates to Dynasty 12 (c. 1985–1795 BC), a period marked by strong rulers who extended Egypt's presence in the Mediterranean and the Red Sea.

Egyptian seafaring expeditions sought incense, gold, live animals and animal skins and other exotic goods from Punt and Bia-Punt in the southern Red Sea, but the ships they used originated as cedar trees growing on the mountains of the eastern Mediterranean, an origin indicated by the term *kbnt* as an adjective for the type of ship used on these excursions. This term is properly interpreted as meaning a seagoing ship of cedar, not a ship built for trade to Byblos or by people from Byblos, definitions that have been suggested previously. Above all else, it is the ship timbers themselves that suggest this definition.

Ancient maritime activities at Gawasis focused on the assembly of seagoing ship 'kits' and staging of months-long voyages by thousands of men on an intermittent basis.¹ These seagoing ships, first constructed in Nile dockyards of imported cedar of Lebanon, were

¹ To my knowledge, Kenneth Kitchen first coined this entirely accurate term.

disassembled and then carried in pieces by men and donkeys across 145km (90mi) of the Eastern Desert to the shore of the Red Sea at *Sannu*. The site is complex, with a number of living and work areas capable of supporting thousands of residents, including two ceremonial areas with shrines, a camping area for tents and food-processing locations, as well as a series of galleries, or long rooms, cut into an ancient, uplifted coral reef (Fig. 5) (Bard and Fattovich 2007; 2010).

The first artefacts unequivocally associated with ships included two wooden rudder blades about 2m long (Zazzaro 2009), stone anchors and blanks for making more anchors, and cedar ship timbers whose exterior surfaces were scarred by the characteristic holes and shells of warm-water, marine mollusk larvae commonly called shipworms (Fig. 6) (Ward 2009; Ward and Zazzaro 2010). Since then, more than one hundred identifiable hull components from an unknown number of ships have been excavated, documented and analysed, along with thousands of pieces of wood debris that tell another story.

Although a number of texts refer to sailing to Punt, only the Hatshepsut reliefs indicate a fleet size (five ships) which would provide safety, redundancy and security. Once the sailors departed, their support crew may have dispersed for a few months to do other work in the region, but when the ships returned from their long journey, the site had to have been a blur of action. Tool marks on thousands of pieces of wood debris, strips of cordage, linen fragments and ship parts excavated at Gawasis attest to the quick work of dismantling each ship.

Some ship timbers were recycled into thresholds, ramps and gallery paving. Others seem to have been stored in the galleries and reused in other ways, such as being cut down into parts for small boats. Even after up to five months of immersion in seawater, the value of the cedar timbers easily repaid the effort to remove barnacles, rotten wood and other organisms from exterior surfaces. Large copper alloy tools such as adzes and saws, axes, chisels and even wooden wedges made on the spot from ship planks left their marks on the chips of wood, splintered bits of planks and the remains of ship fittings abandoned in and near the rock-cut galleries.

The ship parts discovered at Gawasis range from complete planks to short pieces of oar looms (Ward 2010). They are characterised by the use of standard ancient Egyptian techniques documented in river craft and provide the earliest evidence for large seagoing ships anywhere in the world. Two sets of rudder blades have been identified from the later periods of use at the site; the first pair measures about 2m in length, and a comparison of their features with those of ancient images and models of ships suggests that they likely came from a ship about 20m long (Zazzaro 2009). A second set is 4m long and implies a ship length of at least 30m (Ward, Zazzaro and Abd el-Maguid 2010).

In addition, Mohamed Mustafa Abd el-Maguid has studied twenty-five limestone anchors that include all stages of manufacture and use before being recycled as framing for doorways to the galleries. Geological explorations identified a quarry less than 10km (6mi) from the site as the source of the limestone used to create these weight anchors, which relied on the sheer mass of several anchors to provide a secure anchorage for the ship. Maritime artefacts from Gawasis inform us about 20m-long seagoing ships and the level of shipbuilding expertise applied to their construction and operation 4,000 years ago. They, and other finds at the site,

also illuminate the vast administrative and bureaucratic nature of ancient Egyptian frontier activities and confirm relations with other cultural groups from Yemen and Sudan to the south to Minoan Crete and the Levant to the north. Amenemhet III and Senusret I sent seafaring expeditions to Punt from Gawasis, according to inscriptions on stelae erected there by officials responsible for the work (Bard and Fattovich 2010).

Perhaps the most tangible link to Punt came from the discovery of forty-three cargo boxes abandoned and buried in a sand dune that formed outside the entrance of galleries six and seven. Elsayed Mahfouz copied and translated an inscription on one that marked year 8 of a king's reign and described the box's contents: '... the wonderful things of Punt' (Bard and Fattovich 2010). Two other boxes in the same cache included a cartouche that identified the king as Amenemhet IV (c. 1786–1777 BC), the latest dated inscriptions at the site.

The location of Punt remains uncertain, but the number of ceramics from southern Red Sea cultures strongly suggests it was found at the southern end of the Red Sea in the later Middle Kingdom (Bard and Fattovich 2007; 2010). The ship timbers attest to long journeys, and although we do not have an ancient Egyptian seagoing ship to replicate, the variety of timbers and parallels with Nile river craft provide enough evidence to create a 'floating hypothesis' of an ancient vessel, one designed, built and sailed on the Red Sea in 2008–2009.

Experimental archaeology: *Min of the Desert*

Before the discovery of direct physical evidence of seagoing hulls, speculative scholarly discussion addressed the construction of the Punt ships, but none of the projections could be tested, and most relied on the most spectacular example (the 43m-long ceremonial Khufu ship) as a model of construction technology (Edgerton 1923; Landström 1970; Wachsmann 1998; Fabre 2005). Although we do not have an entire ship—or the ability to identify which vessel a particular timber came from or whether any of the timbers came from the same vessels—the assembly-line mentality of common dimensions, shapes and proportions made me confident that the Gawasis data could be used as the basis for a theoretical reconstruction. From 2006 to 2008, I led a team that designed, built and sailed a full-scale reconstruction of an ancient Egyptian ship.

The design incorporates exact copies of timbers from Gawasis, and the specifications of the hull itself, as well as individual components within the hull, reflecting a range of direct and indirect evidence, including the Punt reliefs although they are about two hundred years later than the Middle Kingdom dates for use of the facility at Gawasis. For example, ship component dimensions illustrated in the Hatshepsut Punt reliefs show consistency in proportions for steering rudder blades, beam spacing and dimensions, oar looms diameters and crutch height with many Gawasis examples. That consistency, and similarities between the profiles of Hatshepsut's ships and those of the Middle Kingdom Dashur boats, provided the foundation for a vessel design created by naval architect Patrick Couser (Couser, Ward and Vosmer 2009).

Overall dimensions and body shapes for our 20m-long reconstruction were based on those of the 10m-long Dashur boats, roughly doubled and extended upwards at each end.

Dimensions of individual planks were based on Gawasis timbers or standard features of the Gawasis assemblage wherever possible. Fastening patterns and timber shapes also were replicated. For example, plank thickness varies from 22cm for the bottom planks to 14cm at the sheer (Ward and Zazzaro 2010). The reconstruction is fastened entirely by unpegged mortise-and-tenon joints in double lines along plank edges. In the lower hull, exposure and poor seasoning caused large gaps between planks, filled by linen fibers and beeswax before our departure. No similar stopping materials are known from any ancient Egyptian hulls, but there is abundant linen at Gawasis, and ancient craftsmen knew and exploited the properties of beeswax.

The ship, named *Min of the Desert* for the ancient god of Koptos, was built using the same construction technology seen in the remains of ships launched 4,000 years ago at Gawasis on voyages to Punt. The ship measures 20 x 4.89 x 1.7m deep under its beams and displaces 30 tons with a cargo capacity of about 17 tons. Cedar of Lebanon is unavailable in modern wood markets in the sizes we required, so Douglas fir was used as its physical characteristics such as density, bending strength and ring size are closely comparable. At the shipyard, some modern equipment such as electrical band saws and framing saws for roughing out planks were used, but the primary crew of four men and two teenagers relied on iron hand tools made to ancient specifications for most of the work.

Min of the Desert was not disassembled and put together again after its journey across the desert; instead it arrived by truck (Fig. 7). Captain David Vann supervised a crew of twenty-four international volunteers, including a core crew of five Egyptian sailors, for a week of sea trials on a ship rigged according to a plan lifted straight from the Hatshepsut Punt reliefs. The week-long voyage of 135km south from Safaga towards Mersa Alam followed the ancient route, stopping each night at protected anchorages, some still lined with mangroves like the lagoon at Gawasis in the early 2nd millennium.

The crew used oars to maneuver the ship into position for raising and lowering the sail and once to save ourselves from being blown onto a reef. Lack of practice demanded that we reduce our rowing crew size to fourteen, less than half the number illustrated on the Punt reliefs, but with wide enough spacing for us to avoid catching each others' oars. Despite our inexperience, we reached 2.5 knots against the wind. Nonetheless, rowing was not a primary propulsion strategy for a 30-ton ship with such a small crew (Fig. 8).

Instead, we focused on sailing (Fig. 9). A heavy cotton square sail modeled on the remains of model boat sails and linen fragments from Gawasis measured approximately 14.25 x 5m (c. 80m²). Without the advantage of pulleys, the first raising of sail required two teams of eight and brute strength. It took about three minutes. By the final day of sailing, a six-man crew raised sail in less than thirty seconds while a six-woman rowing crew kept the prow pointed downwind. *Min* sailed across the wind up to an angle of about 100° off the wind, and as few as two rowers could turn the ship 180° in less than one minute (Ward, Couser, Vann, Vosmer and el-Maguid, in press).

Min of the Desert outperformed all expectations, logging an average speed just above 6 knots over six days, with speeds of up to 9 knots. During the voyage, wind speed reached 25 knots, and the swells climbed to 2.5–3.0m, but the ship easily kept to its course and suffered no adverse effects. Throughout the journey, it took on less than 2–3 liters of water per hour,

an amount easily handled by the hand-operated bilge pump we set up each night. The ship itself now belongs to Egypt's Supreme Council of Antiquities and is displayed outside the new Museum of the Sea at Suez.

The Egyptians sailed much farther south on the Red Sea than our trials allowed, probably arriving at Punt by late autumn. It is likely that they returned along the Arabian coast with northbound currents and a south wind from the end of the Indian Ocean monsoon season before spring. This sailing regime was familiar from the Nile: sail south with the north wind, and use the current to travel north, crossing near the modern port of Safaga, which is still a destination for voyages across the Red Sea because of favorable wind and current conditions.

Conclusion

Scholars long underestimated the seafaring capabilities of the ancient Egyptians, but recent excavations beside the Red Sea demand respect for the mastery of shipbuilding technology of about 4,000 years ago. The unique ability to acquire Mediterranean cedar for use in building Red Sea ships provided the Egyptians access to what they called the marvels of Punt. While the frontier staging ground at Gawasis expands our knowledge of how and when they sailed south to return with incense and other cargoes, many details remain obscure.

Nonetheless, ship timbers and maritime artefacts at Gawasis illustrate the technological, administrative and bureaucratic nature of ancient Egyptian engagement with the world beyond the Nile. Studying these abandoned ship planks and equipment—the products of shipyards operating under an approach that recalls assembly-line construction—informs us about ship technology and shipbuilders, as well as the use of watercraft at sea in ancient Egypt.

Min of the Desert relied on archaeological data for its design and internal structure. Thick planks interlocked along their edges and fastened by deep, unpegged mortise-and-tenon joints created its structurally sound hull. *Min's* sailing performance proved that a rig copied directly from the Hatshepsut Punt reliefs was efficient and effective and conclusively demonstrates the feasibility of extended sea voyages in indigenous Egyptian craft.

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Supreme Council of Antiquities proved to be a vital liaison and recorder in the shipyard.

Mahrous Lahma and the shipwrights of Chantier Ebad El-Rahman, Rashid, Egypt, and our core crew of sailors from Lake Borolos, Egypt, deserve special recognition for their good cheer and willingness to build and sail a ship unseen in Egypt for 4,000 years. I especially thank our captain, David Vann, and the international all-volunteer crew for joining us in an untried, experimental vessel and seeing us safely into port at the end of the journey.

Bibliography

- el-Awady, T. 2009. *Sabure – the pyramid causeway: History and decoration program in the Old Kingdom*. Czech Institute of Egyptology; Abusir 16. Prague.
- Bard, K. A. and R. Fattovich (eds). 2007. *Seaport of the pharaohs to the land of Punt: Archaeological investigations at Mersa/Wadi Gawasis, Egypt 2001–2005*. Naples.
- . 2010. Spatial use of the Twelfth Dynasty harbor at Mersa/Wadi Gawasis for the seafaring expeditions to Punt. *Journal of Ancient Egyptian Interconnections* 2.3: 1–13. <http://jaei.library.arizona.edu>, last accessed 2012.
- Couser, P., C. Ward and T. Vosmer. 2009. Hypothetical reconstruction of an ancient Egyptian seagoing vessel from the reign of Queen Hatshepsut 1500 BC. In *Historic ships: The Royal Institution of Naval Architects, 19–20 November 2009*. London.
- Edgerton, W. F. 1923. Ancient Egyptian ships and shipping. PhD dissertation, University of Chicago.
- Fabre, D. 2005. *Seafaring in ancient Egypt*. London.
- Faulkner, R. O. 1941. Egyptian seagoing ships. *JEA* 26: 3–9.
- Glanville, S. R. K. 1932. Records of a royal dockyard of the time of Tuthmosis III: Papyrus British Museum 10056, Part 2: Commentary. *Zeitschrift für Ägyptischen Sprache* 68: 7–41.
- Haldane, C. 1992. The Lisht timbers: A report on their significance. Appendix in *The pyramid complex of Senwosret I*, D. Arnold (ed.), 102–12, pls 115–33. New York.
- . 1996. Archaeology in the Red Sea. *Topoi* 6: 853–68.
- Killen, G. 1980. *Ancient Egyptian furniture* 1. Warminster.
- Landström, B. 1970. *Ships of the pharaohs*. Garden City.
- Lipke, P. 1984. *The royal ship of Cheops*. BAR International Series 225. Oxford.
- Marcus, E. 2007. Amenemhet II and the sea: Maritime aspects of the Mit Rahina (Memphis) inscription. *Egypt and the Levant* 17: 137–90.
- Petrie, W. M. F., F. G. A. Wainright and A. H. Gardiner. 1913. *Tarkhan I and Memphis V*. BSAE 23. London.
- Petrie, W. M. F., F. G. Brunton and M. Murray. 1923. *Labun* 2. BSAE 33. London.
- Pomey, P. In press. The pharaonic ship remains of Ayn Sukhna. In *Proceedings of the Twelfth International Symposium on Boat and Ship Archaeology, Istanbul 2009*, N. Gunsenin (ed.). ISBSA 12. Oxford.
- Reisner, G. A. 1913. *Models of ships and boats*. Catalogue général des antiquités égyptiennes du Musée du Caire, nos 4798–4976 and 5034–5200. Cairo.
- el-Sayed, A. M. 1977. Discovery of the site of the 12th Dynasty port at Wadi Gawasis on the

- Red Sea shore. *Revue d'Égypte* 29: 140–78.
- . 1978. The recently discovered port on the Red Sea shore. *JEA* 64: 69–71.
- . 1980. Observations on recent discoveries at Wadi Gawasis. *JEA* 66: 154–57.
- . 1983. New light on the recently discovered port on the Red Sea shore. *Chronique d'Égypte* 48: 23–37.
- Simpson, W. K. 1965. *Papyrus Reisner 2: Accounts of the dockyard workshop at This in the reign of Sesotris I*. Boston.
- Tallet, P. 2012. Ayn Sukhna and Wadi el-Jarf: Two newly discovered pharaonic harbours on the Suez Gulf. *BMSAES* 18: 147–68.
- Wachsmann, S. 1998. *Seagoing ships and seamanship in the Bronze Age Levant*. College Station, TX.
- Ward, C. A. 2000. *Sacred and secular: Ancient Egyptian ships and boats*. Boston.
- . 2004. Boatbuilding in ancient Egypt. In *The philosophy of shipbuilding*, F. Hocker and C. Ward (eds), 13–24. College Station, TX.
- . 2006. Boat-building and its social context in early Egypt: Interpretations from the First Dynasty boat-grave cemetery at Abydos. *Antiquity* 80: 118–29.
- . 2007. Ship timbers: Description and preliminary analysis. In *Harbor of the pharaohs to the land of Punt*, K. Bard and R. Fattovich (eds), 135–50. Naples.
- . 2009. Evidence for Egyptian seafaring. In *Between the seas: Transfer and exchange in nautical technology. Proceedings of the Eleventh International Symposium on Boat and Ship Archaeology, Mainz 2006*, R. Bockius (ed.), 9–16. *ISBSA* 11. Oxford.
- . 2010. From river to sea: Evidence for Egyptian seafaring ships. *Journal of Ancient Egyptian Interconnections* 2.3: 42–49. <http://jaei.library.arizona.edu>, last accessed 2012.
- Ward, C. A., P. Couser and T. Vosmer. 2007. Building Hatshepsut's Punt ship: Science and ship reconstruction. In *Historical boat and ship replicas: Conference proceedings on the scientific perspectives and the limits of boat and ship replicas*, M.-J. Springmann and H. Wernicke (eds), 36–42. Torgelow.
- Ward, C. A. and C. Zazzaro. 2010. Evidence for pharaonic seagoing ships at Mersa/Gawasis, Egypt. *International Journal of Nautical Archaeology* 39: 1–17.
- Ward, C. A., C. Zazzaro and M. A. el-Maguid. 2010. Super-sized Egyptian ships. *International Journal of Nautical Archaeology* 39: 387–89.
- Ward, C. A., P. Couser, D. Vann, T. Vosmer and M. A. el-Maguid. In press. Reconstruction and sailing performance of an ancient Egyptian ship. In *Proceedings of the Twelfth International Symposium on Boat and Ship Archaeology, Istanbul 2009*, N. Gunsenin (ed.). *ISBSA* 12. Oxford.
- Wilkinson, T. A. 2000. *Royal annals of ancient Egypt: The Palermo stone and its associated fragments*. London.
- Zazzaro, C. 2007. Ship blades, anchors and pierced stones. In *Harbor of the pharaohs to the land of Punt*, K. Bard and R. Fattovich (eds), 150–60. Naples.
- . 2009. Nautical evidence from the pharaonic site of Marsa/Wadi Gawasis. Report on two parts of a steering oar/rudder. In *Between the seas: Transfer and exchange in nautical technology. Proceedings of the Eleventh International Symposium on Boat and Ship Archaeology, Mainz 2006*, R. Bockius (ed.), 3–8. *ISBSA* 11. Oxford.



Fig. 1: The wood-to-wood, mortise-and-tenon fastening has a demonstrably indigenous origin in Egypt and was the primary fastening for seagoing ships of the Middle Kingdom. A trapezoidal slip of wood (tenon) is cut to fit tightly at its centre in a pair of mortises that are placed opposite each other in adjacent planks.

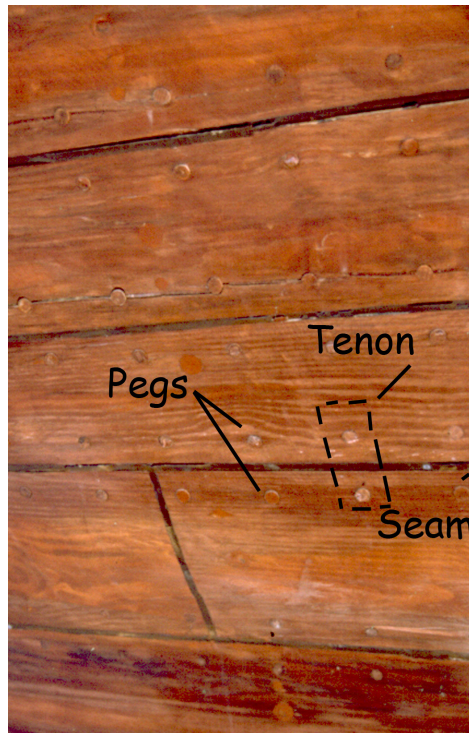


Fig. 2: Mediterranean shipwrights typically used small pegs to lock tenons in place on each side of the plank seam. The pegs were placed perpendicular to the seam as a way to reduce longitudinal slippage along plank edges.



Fig. 3: Planks from the remains of seagoing ships at Gawasis seem to have been less than 3.5m long. Rather than being parallel, edges were shaped to avoid long, straight runs of plank seams, and instead the plank's width varied regularly over its length. Planks were often lozenge-shaped, that is, wider in the centre than at the ends. The planking layout in the hull of *Min of the Desert* illustrates these basic principles of Egyptian hull construction (see above, p. 233–35).



Fig. 4: Finely detailed representations of seagoing ships at Hatshepsut's Deir el-Bahri funerary monument provided the details necessary to create a rigging plan for *Min of the Desert*.

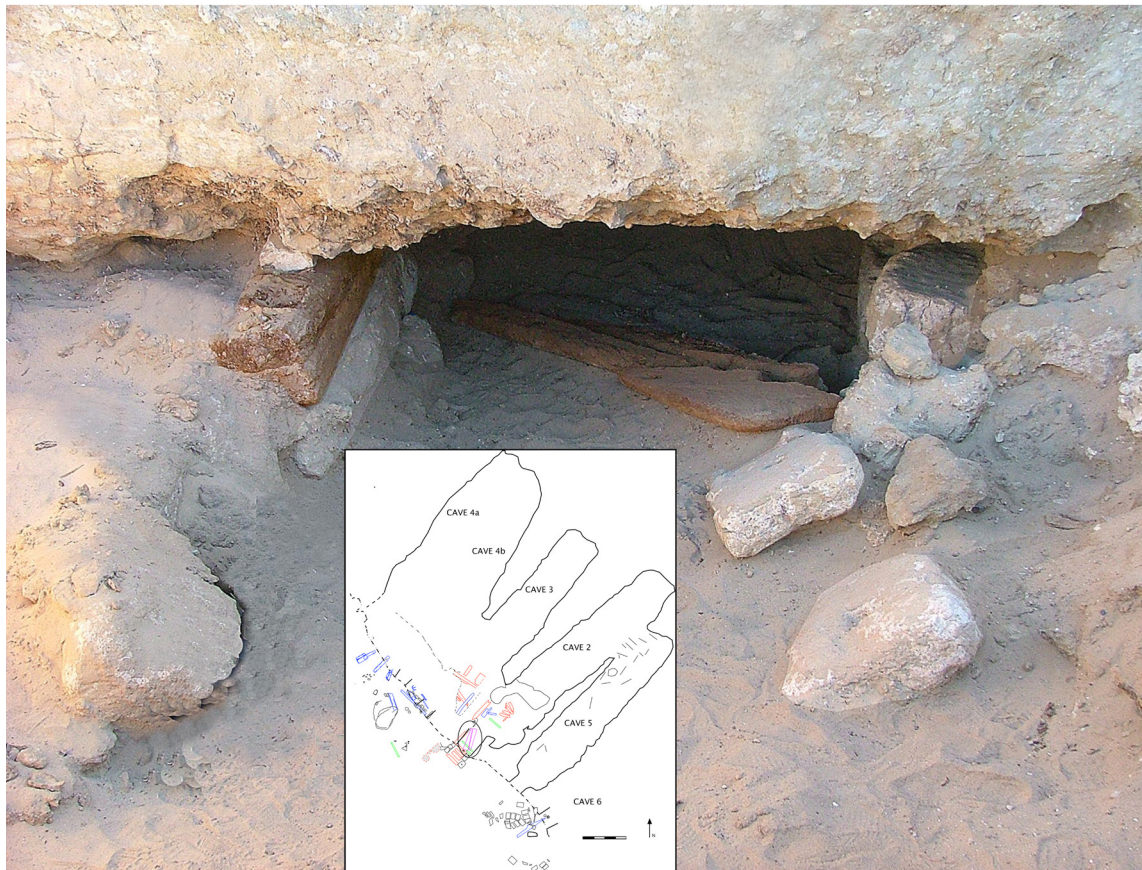


Fig. 5: The archaeological setting of the camp, lagoon, and harbour spaces at Mersa/Wadi Gawasis is complex. A series of galleries were carved into an ancient, uplifted, fossil reef about 1km from the sea, but fronting a lagoon during Middle Kingdom times when the site was most frequently used. Galleries were used for work, living and storage; ship planks were reused as architectural elements within and outside them.



Fig. 6: Larvae of certain warm-water mollusks tunnel into wood immersed in the sea, and this planking fragment of cedar provides a dramatic illustration of the damage they can do over time.



Fig 7: *Min of the Desert* displaces 30 tons over a maximum length of 20m. Built in Rashid (ancient Rosetta) at the mouth of the Nile, it was brought to Safaga on the Red Sea by truck.



Fig 8: Rowing provides speed enough for maneuvering the ship in and out of anchorages, but was unlikely to be a primary propulsion means for the ancient Egyptians at sea.



Fig. 9: Sailing *Min of the Desert* was straightforward and simple, using a rigging plan developed directly from the Punt reliefs of the funerary monument of Hatshepsut.