

The boats published here must, in my opinion, strengthen Crumlin-Pedersen's theory of the expanded logboat as the forerunner of wooden boatbuilding in Scandinavia.

So, where does the skin-boat fit in? One possibility is that it was never used in prehistoric Scandinavia; another that it was the first solution to the problem of building watercraft, but that it was a blind alley, replaced by logboats as soon as trees large enough could be found. A recent MA paper in Scandinavian

archaeology discusses the boats on the rock carvings at Alta on the north coast of Northern Norway. Using new results from pollen analysis, it is shown that pine forests existed near the coast c.4000 BC. The author argues that this indicates the use of logboats, probably extended rather than expanded (Klem, 2010).

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On the Transition from Shell to Skeleton

In the last issue of the *IJNA* (2013, 42.1: 188–208), Seán McGrail published a note entitled 'The Transition from Shell to Skeleton in the Mediterranean and in North-west European Waters' in the wake of our article (Pomey *et al.*, 2012: 235–314). In this note, having stressed the importance of the study for future research on the evolution of Mediterranean ship construction, McGrail returns to the Romano-Celtic tradition in order to correct some misconceptions in our article. His remarks led us to clarify our thinking regarding Romano-Celtic construction. We also take this opportunity to make some additions to our study with a presentation of the Conque des Salins shipwreck, which is possible evidence of influence from north-western Europe; a recent bibliographical reference regarding the possibility of extra-Mediterranean influence (Martino, 2011); and a note on the Dor 2006 shipwreck, which complements our corpus of study and underlines the important contribution of the Dor-Tantura shipwrecks.

The Romano-Celtic tradition

McGrail's note has led us to make several clarifications regarding the construction of Romano-Celtic seagoing boats and ships. Firstly, we wish to emphasize that we raised the question of Romano-Celtic shipbuilding only in order to integrate this tradition into our discussion, without developing a full scientific argument. In addition, it seemed important to us to note that a scientific debate existed around the definition of the principles and methods of construction of Romano-Celtic seagoing boats and ships in terms of 'proto-frame-based' and 'bottom-based' shipbuilding (Arnold, 1998: 78–81). Moreover, we clearly differentiated between the concepts of architectural principles (theoretical process of structural and shape design of the hull) and methods or processes of construction (practical translation in the shipyard of the architectural principles) (Pomey, 1988, 2004). In other words, a 'bottom-based' architectural principle does not exclude the recourse to

‘proto-frame-based’ methods of construction. Lastly, we raised this question tentatively, taking into account, in particular, the small number of shipwrecks of seagoing Romano-Celtic vessels compared to the large archaeological archive relating to numerous wrecks of Mediterranean seagoing vessels, so we often employed the conditional mode and quotation marks. We now wish to expand on the subject as follows:

1. We wrote (p.304) that ‘The vessels were not built “on keel”, but on a flat bottom. . .’. The quotation marks underline the fact that these vessels do not seem to have been designed with a continuous longitudinal structure, arranged in the same plane, and composed of the keel (as a vertical flat board) and stem- and sternposts, defining the architectural axis of symmetry; and, moreover, with continuity of form and structure between the bottom and the sides.
2. The seagoing Romano-Celtic vessels were not equipped with a ‘keel’ with an active function in the construction of the hull, but of three horizontal ‘keel-planks’ in the St Peter Port wreck, and two in the Blackfriars 1 and Barland’s Farm wrecks.
3. These two or three ‘keel-planks’ were not joined, but laid edge-to-edge like the traditional strakes of a strictly ‘bottom-based’ river barge, and constituted a kind of *mini-sole* as part of the construction.
4. In our view, the ‘keel-planks’ of the seagoing Romano-Celtic vessels do not correspond to the full and strict ‘*sur sole*’ construction of the river barges designed and built ‘bottom-based’.
5. Even if these ‘keel-planks’ ‘. . . were significantly thicker than the bottom planking’ and ‘protruded into the water below the general level of their bottom planking’ (McGrail, 2013: 188), they are not comparable to a keel (within the meaning of our definition), and play a different role from that of a ‘pure keel’ (a vertical flat board) at the levels both of design (architectural and hydraulic principles—longitudinal strength, moment of inertia, and reduction of leeway) and construction (building process) of the hull.
6. Lastly, the construction of these seagoing ships can be considered, at the level of shipyard practice (methods of construction), as techniques ‘. . . “proto-frame-based”. . . as a practical solution’ (Pomey *et al.*, 2012: 305). It is in this sense that we wrote of the process of transition according to the chronological scale that ‘. . . At the same period (second half of the 2nd century AD) a sort of transition to skeleton could have been under way in NW Europe according to the “proto-frame-based” method of building used in the “bottom-based” Romano-Celtic shipwrecks’ (Pomey *et al.*, 2012: 305–306).

So, we believe that our points of view on the actual construction are not so different. We hope that these clarifications answer McGrail’s comments.

Conque des Salins shipwreck (Fig. 1)

The Conque des Salins shipwreck was discovered in 1998 in the Étang de Thau (Hérault, France) (Rouquette *et al.*, 2004; Jézégou *et al.*, 2009; Jézégou, 2011). The wreck is dated to the Roman imperial period. The preserved remains measured 7.70 by 2.20 m, and contained four frames and ten strakes, including the keel. The cross-section was flat-bottomed amidships, with a faceted round turn of the bilge.

The keel was a thicker plank than the rest. It was made of two elements connected by a diagonal joint. The central part was 50 mm thick, and the end element was up to 90 mm thick. Lead sheathing toward the end protected the keel. The planks were on average 180–210 mm wide and 34 mm thick, except the garboard, which was 46 mm thick. Planks were connected by diagonal joints (except for one curved joint). The strakes and the keel were connected by pegged mortise-and-tenon joints. Mortises, with spaces between adjacent edges of 140–200 mm, were 55–100 mm wide, 7–15 mm thick, and 50–90 mm deep. Tapered tenons were 45–90 mm wide, 100–180 mm long, and 5–9 mm thick. Some planks had been repaired.

Four frames survived, of the six frame stations that were identified. They were 100–140 mm sided and 90–115 mm moulded, with a large room and space of 800–960 mm. Frames were connected by iron nails to the planking, and three of them were also nailed to the keel. The mast-step was a floor timber reinforced on one side by a parallel timber treenailed to it. The inside of the hull was covered by a thick layer of pitch to ensure it was watertight.

In interpreting the Conque des Salins wreck, M.-P. Jézégou links it to the Mediterranean tradition, and finds a parallel in the Cap del Vol wreck, which also had a flat keel. However, the latter had an axial structure with a keelson-mast-step of totally different concept, and a system of frame assembly by ligatures and treenails, characteristic of a well-defined Mediterranean group (Pomey, 2002). Clearly the two shipwrecks do not belong to the same architectural family. On the other hand, the Conque des Salins wreck has both characteristics that belong to the Romano-Celtic maritime tradition (keel-plank, frames attached with iron nails, floor timber-mast-step), well attested by vessels of NW Europe (Blackfriars 1, St Peter Port, Barland’s Farm), and characteristics that belong to the Mediterranean tradition (planking assembly by mortise-and-tenon joints, and the use of pitch for watertightness). This is why, according to Pomey (2011: 14), the Conque des Salins wreck very probably belongs to a local Romano-Celtic tradition with strong Mediterranean influences. Thus this typical lagoon boat testifies to a Romano-Celtic influence on ship construction in the Mediterranean, and could be an important

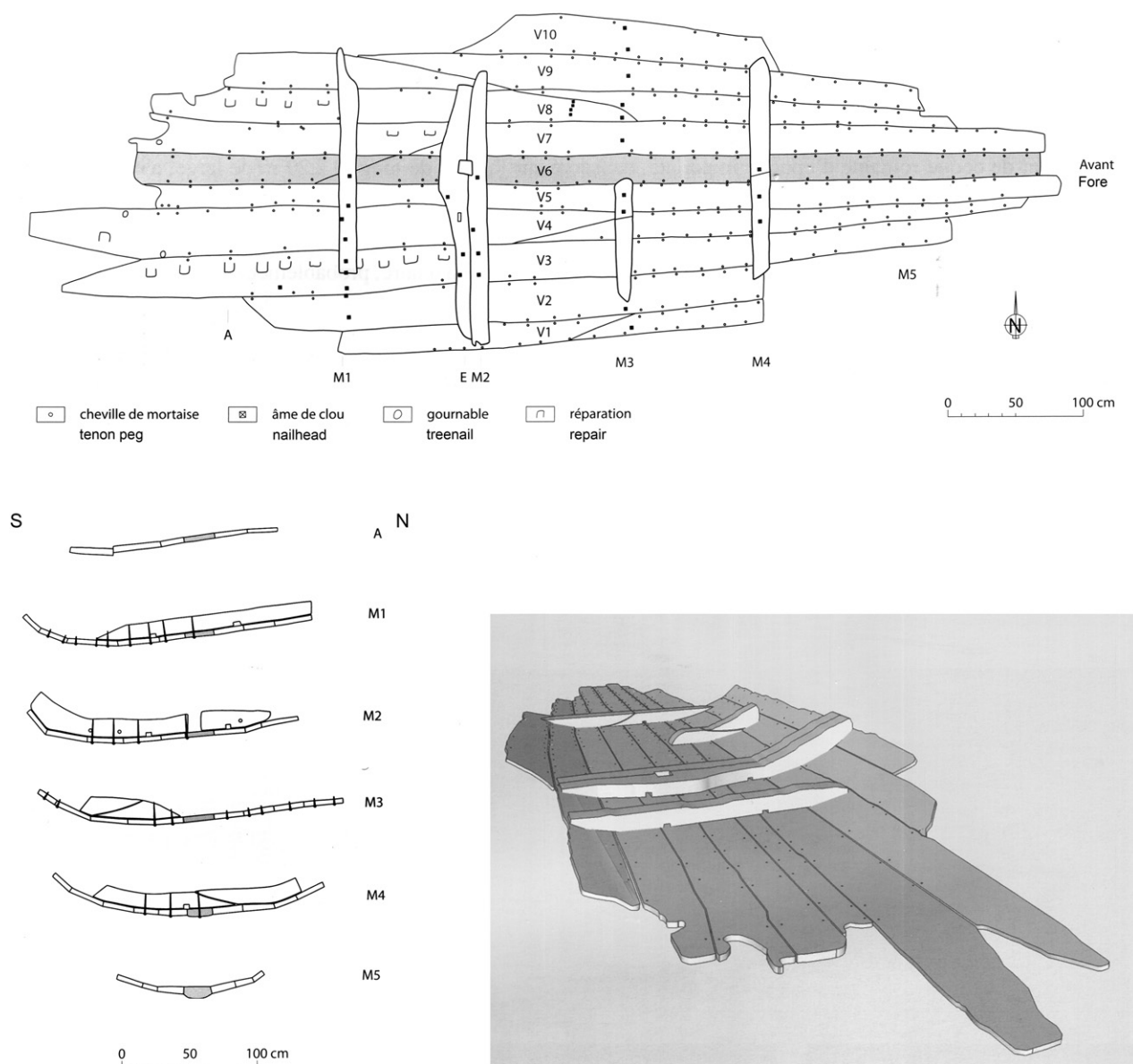


Figure 1. Conque des Salins shipwreck: hull plan, cross-sections, axonometric 3D restoration. (With permission, Jézégou 2011, figs. 1, 7 and 12)

element in the discussion of extra-Mediterranean influence on the transition process (Pomey *et al.*, 2012: 304–305).

‘Sulle origini della carpenteria moderna’

This paper, published by S. Martino in 2011, has as its subject precisely the question of the transition from shell to skeleton in the Mediterranean. The author first rejects the idea of an internal evolution of Mediterranean ship construction, due to the incompatibility between the shell and skeleton concepts that would confirm the precocity of the frame-based con-

struction of the Tantura A and Dor 2001/1 shipwrecks. He then suggests that Celtic and Romano-Celtic ship construction, then the contribution of the Vandals, would be the origin of the Mediterranean skeleton construction.

We obviously disagree with Martino’s position, which ignores hull analysis based on the principles and methods of construction (Pomey, 1988, 2004), and rejects the shell and skeleton principles in forgetting that processes reflect many interactions between the two (for example, the active frames that were skeleton solutions to shell problems highlighted by Christensen in 1973), and which denies any progression from shell

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to skeleton; while we have evidenced several possible roots of transition.

However, the idea of an extra-Mediterranean influence, including Romano-Celtic ship construction and Barbarian influence seems to be quite possible, as we have also suggested (Pomey *et al.*, 2012: 236, 304–305), and must be explored.

Dor 2006

(Pomey *et al.*, 2012; Navri *et al.*, 2013, Barkan *et al.*, 2013).

A preliminary hull construction report for the Dor 2006 shipwreck, after three excavation seasons, appears in this issue. Basic information, with some from the fourth season, including significant data regarding the transition, is summarized here.

The shipwreck was discovered in 2006, 800 m south of Dor (Tantura) lagoon, Israel, 100 m off-shore, and was excavated in 2009–2012. The wooden hull remains spread over 10.5×4.52 m on the seabed, and included sections of large frames, stringers and ceiling planks, a transverse beam, a large number of strakes, and five wales. The timbers indicate a 25 m-long hull. The shipwreck was dated to between the second half of the 6th and the first quarter of the 7th centuries AD.

The lower 15 strakes incorporated a system of unpegged mortise-and-tenon joints. Mortises were 38–63 mm wide, 5–6 mm thick, and 24–35 mm deep. Hardwood tenons, tapering in width and thickness, were found in all the mortises. They were 26–32 mm wide in the seams, occupying about 60% of the mortise width, 4–5 mm thick, and 26–30 mm long (half-length). The unpegged tenons served to align the planks, which were later secured by frames. Thus the concept and construction sequence of this part of the hull was shell-based. The upper part of the hull was

based on frames. Thus, as a whole this hull was built in a mixed shell-and-frame construction. The cross-section amidships did not have flat frames.

The Dor 2006 ship, although found near Dor lagoon, is different in its construction from the other shipwrecks dated to the Byzantine and Islamic periods excavated at Dor: Tantura A, Dor 2001/1, Tantura F, Tantura E, and Tantura B (Pomey *et al.*, 2012). It was too large to use the Dor anchorage—all the other shipwrecks were smaller—but lighters could have been used for loading and unloading. The significant difference in construction technology between Dor 2006 and the other contemporary shipwrecks from Dor is evidence of the parallel existence of two different construction traditions of the ships sailing in the area at this period. Most of the shipwrecks in Dor lagoon are attributed to a riverine construction tradition (Pomey *et al.*, 2012: 303–4, Root 4). The construction tradition of Dor 2006 may be related to the evolution of the Hellenistic tradition (Pomey *et al.*, 2012: 303, Root 3).

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A Viking Age Clench-Nail Tool from Sigtuna, Sweden

Recently in this journal I presented my research on clench nails, tools and other artefacts associated with 10–13th-century boat building and boat repair in Sigtuna, Uppland province, Sweden (Edberg, 2013a). In this short note, I report an additional unusual and interesting find, namely an iron nail-heading tool. In smithies where nails and clench nails are manually produced, nail-making tools are necessary for hammering out the heads of the nails. (Ohlhaber, 1939: 75).

The Sigtuna tool is 80 mm long, 24 mm wide and 7 mm thick (Fig. 1). A single round hole traverses the object and is slightly conical, 4 mm in diameter. It weighs 55 g. The iron has obviously been fitted to a wooden handle or helve. It thus has a different design compared to, for example, its counterparts from the Mästermyr chest, well-known to students of Viking Age handicraft (Arwidsson and Berg, 1983: 31, pl. 23:86) and Hedeby (Westphalen, 2002: 38–39, Taf. 5, 6–7).

The size of the tool's perforation agrees very well with the size of the cross-section of the scrapped clench nails which are found in thousands throughout the town's 10–13th-century occupation layers. These clench nails, to my mind, testify to large-scale boat building, repair and scrapping of boats. The iron nail-heading tool thus can be seen in the context of the mass production of these and similar clench nails.

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Figure 1. Nail-making tool from Sigtuna, Sweden. Approx. 1040–1050 AD. (Photo: author)

The tool was found when excavating the Professorn-1 site in Sigtuna in 1999–2000. Very heavy corrosion, the type of object and its peculiarities meant it was not recognized until after conservation. This excavation is not yet reported in full, but the tool's find context can preliminarily be dated to approximately AD 1040–1050, that is at the end of the Scandinavian Viking Age (Edberg, 2013b).

Finally, a correction to my previous note (Edberg 2013: 199): according to a rough estimate, Sigtuna's occupational layers contain 25 tonnes of slag (not 7.5 to 10 tonnes). Iron scrap is roughly estimated as 15 tonnes.

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