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Bollards and Men

D.J. BLACKMAN

Modern study of ancient harbours in the Mediterranean virtually begins with the *magnum opus* of Karl Lehmann-Hartleben.¹ This work is, I suspect, more often quoted than read, even in the abbreviated version which appeared soon afterwards in Pauly-Wissowa's encyclopaedia. This is understandable in a way, for his catalogue of sites is a good starting-point for the study of an ancient harbour and can be managed without much knowledge of German; and consultation of the index provides the main references to a site in the text. But it is important to do more than this: Lehmann-Hartleben did not just write an exhaustive site catalogue, but made the first attempt in modern times to analyse the development of harbour construction in the Mediterranean area in antiquity.

I wish to start by emphasizing the merits of his work, particularly since I intend to disagree with one of his underlying assumptions, one which I think has influenced those later scholars who actually read his work, and indirectly also others. He seems to take it for granted that methods of harbour construction progressed evenly and universally, as regards both increasing size and greater sophistication of technique: on this premise small harbours are likely to be early and even more so harbours built with primitive techniques (the key word 'primitive' is significant in its implications).

Let us concentrate on the development of harbour construction methods, and ask some questions even if we cannot answer them as yet. When technical progress was made in the ancient world, how quickly would the knowledge have spread, or been allowed to spread? Even if the information was available, would local engineers and workmen have had the skills, or the resources, to implement it? My questions on this subject were revived by Hohlfelder's stimulating paper at the 1983 workshop in Caesarea.² He plausibly argued that Corinth itself financed the construction of its eastern port at Kenchreai with little or no outside help, using traditional technology and engineering skills to produce the type of harbour Corinth required, a municipal harbour of limited scale, with construction work apparently lasting a considerable time. He then continued:

The absence of any of the new technology employed at Sebastos is

also not unexpected. If Augustus had chosen not to send his master builders to Kenchreai, or was not asked to do so, it seems that Kenchreai's engineers would not have had easy access to the innovations that distinguished Sebastos. It is most probable that at the time, only a few individuals knew the secrets of hydraulic concrete and the other 'modern' features of Herod's harbour. When and if this knowledge was ever widely disseminated is unknown, but it is very unlikely that local Greek harbour builders and artisans could yet implement the advances of Sebastos without outside assistance.

Hohlfelder concluded that in the natural deep-water bay of Kenchreai traditional solutions (rubble breakwaters) worked well.³

I wonder whether knowledge of such advance as the use of hydraulic concrete really could have been kept as an *arcanum* for at least a century; we now have sufficient examples of its use, if only on a limited scale, and I find it difficult to assume the presence of imperial master builders every time. On the other hand, use of this and other 'modern' techniques on the scale of Herod's work at Caesarea is a very different matter; this would have required resources of men and materials, a skilled work force and finances on a scale which would not have been available to most cities of the Roman empire. Unless there was a direct imperial interest – connected, for example, with the operations of the navy or the grain fleets – local initiative and self-sufficiency were encouraged.⁴ Therefore, when Corinth built rubble breakwaters in traditional style at Kenchreai in the Roman imperial period, this was, I am sure, an experience typical of the smaller cities of the provinces: cities which could not afford to bring in outside help – engineers from Italy or elsewhere with all the latest expertise – and undertook what was needed and perhaps not much more.⁵

If this line of argument is accepted, then Lehmann-Hartleben's underlying assumption needs to be reconsidered. A detailed analysis of all the evidence would require a complete book; my aim here is a cautionary note. The human factor must always be taken into account: men would build according to demand and their own resources. Of course one must allow for civic pride, collective and individual, but also for hard-headed financial calculations, particularly when structures needing maintenance were involved. There was no need to build harbours larger or more sophisticated than required; the same was true for ships⁶ – larger ships would only cause problems of harbourage, reminiscent of the parallel of modern tanker development. On reflection I am impressed by the number of *small* harbours in the ancient world.

Not for others the megalomania of Herod – a worthy successor of the Greek tyrants of an earlier age, such as Cypselus and Periander of Corinth and Polycrates of Samos. Ancient tradition rightly associated the latter with major developments in public works, and it is clear that in the period of Greek colonization in which they played such an eminent role, burgeoning trade, particularly by sea, must have increased the need to develop harbour facilities. Periander instituted transit tolls on traffic through the ports of Corinthia, built the *dolkos* across the isthmus and proposed to cut a canal. I would attribute to him the development of the port of Lechaion, though we lack explicit ancient literary evidence. Polycrates is linked with the first construction of Greek harbour works attested in classical Greek sources. He had the commercial and military motivation, and a work force which needed employment and one which must have become very skilled in engineering projects. He also had coinage to pay for labour and materials – an underestimated factor, I believe, in the development of public works in that period.⁷ Unless trade was entirely counter-trade (which at the least was less likely as time passed), it would have produced a valuable source of revenue, some of which would have been spent on the development and operation of harbours, and was perhaps already supplemented by harbour dues. By whom, and how, were harbour construction and operation administered and financed? These are only two of the questions which should be raised.

It is not, however, enough to ask the human questions. With the continuing threat to the survival of ancient remains, we must do our utmost to record them. As Geoffrey Rickman allows, ‘every last bollard must be counted and classified’.⁸ **Mooring stones and bollards continue to intrigue me.** For example, I still cannot definitely explain the *horizontal* bollards which we found at **Phaselis**, and for which I know of no parallel. The quay on the south side of the central harbour has neither vertical bollards set in its upper surface (or, at least, no remains surviving) nor pierced stones projecting from its face, but bollards projecting horizontally from its face at **intervals of between 2.7 and 6.5 m.**; five can be traced of which only one is well preserved. Could ships really have made fast to them? Or were fenders or cables slung from one to the next along the face of the quay? Alternatively, were they used for careening ships? – in which case, how did ships using the quay make fast? The explanations need not, of course, be mutually exclusive.⁹

Typical of many quaysides, in the Roman period and probably also earlier (for example Teos), are the pierced mooring stones projecting from the quay faces. The quay at **Teos** in western Asia Minor (probably

third century BCE) provides some fine examples, mostly set at intervals of 3.4–3.5m., and wedge-shaped to take the lateral strain. The course above that containing the mooring stones has almost entirely disappeared, but it must have existed; the course below it projects by 40–50 cm. on an inner stretch of quay, and by 30 cm. at the western (inner) end of the main stretch of quay (though narrowing to nothing at the seaward end). The question of the vertical profiles of ancient quay faces remains to be studied; a broken profile would help to break up the force of waves striking the quay.¹⁰

I still have no certain answers to some questions which I have posed in earlier publications: could wooden spars, or even metal bars, have been inserted in the mooring stones – to serve as massive cleats? Could mooring cables have been slung from one to the next, or rubbing timbers been inserted? Apart from a report of metal bars at Ventotene (ancient Pandateria) there is no material evidence to support the idea, but many mooring stones show a remarkable lack of abrasion. On the other hand, some mooring stones are clearly worn, and the pictorial evidence of the Torlonia relief shows a mooring rope apparently made fast directly to the stone. One further method seems to have been the use of metal rings, reported from several sites; ships' mooring ropes could also have been protected from wear by being made fast to slings of wicker or heavy cable attached to the mooring stones.¹¹

An intriguing find was made at Kition in 1879. During removal by the Royal Engineers of much of the 'mound of rubbish' known as Bamboula, many ancient remains were discovered, but very inadequately recorded, before being dumped into the adjoining marsh which had undoubtedly originally been the ancient harbour and which caused malaria in the summer months. A copy of the report by the officer in charge was discovered in the British Museum archives and published by Bailey in 1969.¹² One extract reads as follows: '... at E were found two stones with holes through them fixed in the ground and apparently used for fastening the ships in harbour ...'. This passage is quoted in several more recent descriptions of the site: by Karageorghis, who somewhat non-committally says that these and other finds 'give an indication of the nature of the buildings which were destroyed', and by Nicolaou in his chapter on the harbour of Kition, who adds: 'These of course may be anchors probably reused as building material.'¹³

There are, however, two further descriptions of these lamentable operations by an eye-witness, the notorious Max Ohnefalsch-Richter. In one of these, which appeared in a now rather inaccessible periodical, he adds some important details about the stones: that they were

columns which stood at the edge of the marsh below and in front of the 'circuit wall'; that they were pierced horizontally with round holes through their upper parts; and above all, that they were about 7m. high.¹⁴ Thus there can be no doubt that they were not anchors, but mooring stones or rather columns (we are given no exact indication of their shape beyond the word 'Pfeiler'). Were these 'columns' or 'bollards'? I find it difficult to think of a bollard 7m. high, so probably we should accept a distinction according to size. Unfortunately some references to columns, even 'columns with iron mooring rings', give inadequate details of size. Where tall columns without perforations or attachments are found on quays we must think of other functions rather than mooring – notably support for a roof or at least a light covering. Some may have served a double function – for example the numbered columns in Trajan's harbour at Portus;¹⁵ not, however, a double function of mooring and support.

On rock-cut quays short columns of natural rock could be left to serve as bollards or 'bitts'. A series has recently been found in the ancient harbour of Apsorus in the northern Adriatic.¹⁶ Alternatively, holes were cut obliquely through the lip of the quay.

Actual mooring methods remain unclear. One must assume that for manoeuvring within a harbour merchantmen did not have to rely on their steering oars alone, but were helped by small boats and probably by hauling on ropes made fast to the mooring stones or bollards (perhaps also to winches, but we lack the evidence). Rickman assumes that they 'anchored obliquely prow first, like diagonal car parking today', and wonders how closely they could be packed. Oblique mooring sounds sensible, but how firm is the evidence? The Torlonia relief seems to show an oblique position, but should not I feel be treated as a photograph. Bringing a merchantman's prow or stern right up to a quay would have been awkward for unloading and have risked damage to prow or stern; an oblique position would be easier, but I suspect that merchantmen were normally moored broadside on and close to the quay for the actual operations of unloading and loading, and then swung to fore and aft (or oblique) moorings to vacate quay space. Where space was limited, they could have been moved away from the quay altogether. Cnidus provides an example of mooring stones in the harbour wall close to but not at a quay.¹⁷ At Puteoli and Misenum mooring stones projected from the piers of the arched moles.

River harbours were a different matter, of course: at riverine quays broadside mooring must have been the rule, even at Aquileia where the river was 48m. wide. This is only one aspect of a question which deserves further consideration: how different in antiquity were river harbours and coastal harbours? Ruegg plausibly suggests a third

category – ‘river seaports’. Rickman also questions whether we should worry about the marked differences in the distances between mooring points in different harbours – 14–16m. in the Trajanic harbour at Portus, 3m. at Leptis Magna, 18.5m. at Terracina. He could also have referred to the considerable variety noted at a single site – for example at Aquileia 14–18m., 21.3m. and 24m.; at Ventotene distances ranging from 4.10m. to 17m.¹⁸

I do not feel concerned about the differences, particularly in the case of shorter distances; after all, one could not reliably calculate the ship beam or length from these shorter intervals, since we must assume that in antiquity, as now, at least two springs would be used. It would be worth checking the minimum spacing known (to the best of my knowledge, 2.7m. at Phaselis, 3m. at Leptis Magna, 3.4–3.5m. at Teos) as some indication of the minimum spacing possible for ships moored stem or stern to at a quay; but this assumes two springs to a single mooring stone. We may alternatively see the close spacing of mooring points as simply providing flexibility of operation.

I am more interested in the possibility of patterns in the longer intervals, and in groupings. The mooring stones on the east mole at Leptis are 3m. apart but fall into groups of three, separated by steps, producing an interval of 11m. The rock-cut mooring bitts on the east mole at Ventotene seem to be at very varied distances, but an imaginative eye could create a unit of about 17m. in length.¹⁹ It would be interesting to know the spacing of the mooring bitts recently noted at Apsorus.²⁰ We are, I think, on firmer ground with the mooring stones set at the top or foot of ramps at Terracina and at Rome (Marmorata). Unfortunately, too short a stretch survived at Rome for reliable figures, but at Terracina the spacing is 18.3–18.6m. One is reminded of the 14–16m. spacing in Trajan’s harbour at Portus.²¹

This is all speculative, but it would be worth testing the idea by looking again at all the evidence, including the numbered columns at Portus. As Rickman has emphasized, it is very difficult to form a picture of how ancient harbours actually worked (with the possible exception of shipsheds). Let us hope that this and other questions discussed above will be clarified by the important new finds of massive quays at Caesarea and in the commercial harbour of Carthage; nor should one forget smaller-scale structures such as the harbour at Phalasarua or the Roman quay at Laurons, now under investigation.²²

The monumental structures associated with quays – *horrea* and stoas – have left solid remains which have been studied; but we have not made sufficient allowance for lighter structures, for example of wood, or wood and wattle, or wood and canvas, whose traces may have disappeared or been overlooked. One could expect some of the more

permanent of these structures to have had slots or 'post-holes' in the quay surface.²³

More solid foundations would have been needed for machinery such as winches and cranes. The presence of winches remains to be proved, but there is no doubt that cranes were available in the Roman period. Vitruvius talks of 'storks (*ciconiae*) rigged for loading and unloading ships, some fixed vertically, some fixed horizontally on revolving platforms'.²⁴ We even know the word for 'professional crane operators' – *professionarii de ciconiis*. But where are the remains of cranes? A timber construction would need a solid fixing for its base. The only possible example known to me is at Roman York, where a riverside quay has remains of a base which may have been for a crane.

A curious graffito in the theatre of Sabratha appears to show a floating crane and a five-masted ship, but I am not happy to rely on a drawing. Paula Williams tentatively raised again the possibility of a crane being depicted on the mosaic of the shippers of Narbonne from the Foro delle Corporazioni in Ostia, but Casson's answer seems final – that the key part is the *artemon* sail of the ship approaching a tower.²⁵

Questions of water-supply and drainage of harbour areas deserve fuller attention. As regards drainage, an exception may be made: the drainage system of the whole area by the harbour of Kition has been fully studied;²⁶ at a simpler level, it was noted that the quay surface at Terracina and Miletus and a rock-cut quay at Cnidus sloped seawards.

From the mariner's point of view, the supply of fresh water was much more important. An essential facility in ancient ports, it figured prominently in ancient, as in modern, coastal pilots; it was, after all, precisely the information which the mariner needed. A number of aqueducts have been traced leading towards harbours, but except at Misenum the terminals remain to be identified. A long aqueduct was built at Caesarea, but do we yet know where the water supply reached the harbour? Some wells and water-tanks have been noted, but one would expect evidence of some kind at every harbour site. Fresh water was also needed for other coastal activities, such as purple dye factories and fisheries.²⁷

The question of road access to ports and roads within port areas has barely been studied so far; nor, since Lehmann-Hartleben, has the problem of the landward limitation or internal subdivision of port areas. The subject of access to the port from the sea has received some attention, but not enough. This was another point of particular interest to ancient mariners. Ancient coastal pilots and geographers refer continually to whether a port had a *limén kleistós* (or more than one). This has usually been explained as a harbour 'enclosed' within the city walls or 'protected' by them; but the form of the verbal adjective

kleistós suggests the meaning 'closable', and the mariner approaching a harbour would have been more interested in knowing whether he might find the harbour entrance closed when he arrived. Further study is needed of the evidence for harbour defence methods, particularly at the entrances. Chains were clearly fixed across harbour entrances, normally between towers as Vitruvius prescribed (5.12.1), but sometimes between flimsier mooring points. This may indeed have been a main function of towers at the end of moles, besides serving as artillery platforms. Chains would have been let down when not in use, and both ends would have presumably remained fixed; because of the weight they would have needed powerful machinery to raise them, and probably floating support when raised.²⁸

Certain other questions were adumbrated by Lehmann-Hartleben and deserve further consideration. How many harbours served exclusively one specific purpose, and what were their distinctive features? I am referring to harbours serving private residences, from villas to palaces; harbours at religious sanctuaries; harbours serving for the export and import of certain commodities (grain, minerals, and marble, for example); fishing harbours; and military harbours, from tiny fleet stations to the great fleet bases of ancient Athens and Rome (the remains of the former being now almost completely lost and the remains of the latter not as fully studied as they deserve). How often do we have to make deductions from the general context of the port in the wider sense, rather than from identifiable specific features of the harbour installations? And how many really single-purpose harbours were there?

There would have been advantages to a certain separation between civil and military harbours, and between them and the rest of the port area, when matters of customs dues were involved and above all for security reasons in the area of military installations. We have clear evidence on this last point from ancient sites such as Athens, Carthage and Rhodes.²⁹ But there must have also been arguments against unnecessary distance and separation; it is likely that even in the largest ports the authorities would have wanted to use the same skilled labour force in any part of the port.

Harbours with a military purpose may be distinguished by the presence of shipsheds, which do seem to have been used only for warships.³⁰ Oddly, those found seem to be almost all classical or Hellenistic in date, and form a large part of the surviving harbour structures which we can definitely establish as pre-Roman.³¹

Few shipsheds have yet been found which are definitely of Roman date, but they were doubtless widely used.³² It is not yet clear whether, and if so how often, timber was used on the slipways, as 'skidways'; nor

whether capstans, winches, or similar apparatus were installed at the head of the slipways, though this seems likely with at least the steeper ones.³³

Some have assumed that major operations could have been carried out on warships within the shipsheds. This seems to me most unlikely in normal shipsheds, where I do not think that anything more than light repairs could have been effected. This leaves unanswered the question of where warships (and merchant ships) were built, careened and pitched. Some indication may be given by the open area around the pair of slips at Sybaris/Thurii – here at least there was an unusual amount of room around them.³⁴ At Oiniadai there were recesses at the head of each slip and at one side of the rock-cut chamber which contained the five slips, but could these have served for more than storing gear? Let us hope that the slips can be re-studied and more fully excavated.³⁵ The slipways at Dor are of interest in this connection: the rock-cut 'basin' by the innermost one *could* have been used for pre-soaking timbers for shipbuilding (and there is a similar side chamber at Matala), but these may simply be storage chambers unless it can be proved that they contained water. Perhaps Ventotene might have offered some evidence if it had been thoroughly studied before so much of the site was built over.³⁶ It would certainly be interesting to know more about the mysterious structures at Fos – two complexes of 156 blocks in six parallel rows which could have been the bases for timber posts.³⁷

In the end we come back to the conclusion, on present evidence, that much of this work must have been carried out on light impermanent structures which would have left little trace, like the timber grids and slips still seen on Mediterranean beaches today. One would expect them to be away from the centre of other harbour operations. But if one explanation for the horizontal bollards at Phaselis is correct, namely that they were used for careening, then that operation was carried out there virtually in the centre of the city!³⁸

I cannot leave the subject of shipsheds without referring to the finds made by the Shaws at Kommos in Crete: a set of five parallel galleries of Late Minoan III date, 5.48–5.96m. wide and over 25m. long, open-ended at the west (seaward) end. I am not yet fully convinced by their suggestion that these galleries are shipsheds; not that I have any objection in principle to the idea of shipsheds so early in date, but I find difficulty in their distance from the shore (over 100m.) and their original height above sea level (about 6m. according to the Shaws), even if we take into account the long gentle incline from the sea.³⁹

My last lacuna is a chronological one – our lack of evidence of early Byzantine harbour construction. We now have evidence from Caesarea to confirm Procopius' reference to a major reconstruction

effort in the early sixth century CE following extensive damage to the harbour complex, but what of all the other harbour construction work referred to by Procopius?⁴⁰

After we finish counting bollards (before they disappear under the onslaught of the bulldozer), we should not forget the most important questions which we must ask and try to answer; and these will be human questions, as Rickman and McCann have rightly stressed:⁴¹ why did they build here? how advanced were their skills? how did they finance the work? who were the organizers? what was life like at the dockside? what were the rules of port operation? and so on. These questions must be borne in mind when we look again at Lehmann-Hartleben's great work. Our aim is a contribution to human history.

NOTES

1. K. Lehmann-Hartleben, *Die antiken Hafenanlagen des Mittelmeeres*, *Klio*, Beiheft 14 (Leipzig, 1923; repr. Aalen, 1963). The subtitle of his book reveals his prime interest in harbours as an aspect of town planning in antiquity: *Beiträge zur Geschichte des Städtebaues im Altertum*. The shorter version: Pauly-Wissowa, *Real-Encyclopädie*, Vol. XIII (Stuttgart, 1926), pp.547-69 (s.v. 'Limen').
2. R.: Hohlfelder, 'The Building of the Roman Harbour at Kenchreai: Old Technology in a New Era', in A. Raban (ed.), *Harbour Archaeology*, British Archaeological Reports (hereafter BAR), International Series, 257 (1985), pp.81-6.
3. *Ibid.*, p.85.
4. *Ibid.*, n.15, appositely refers to the letters of Trajan to Pliny, commending the governor for finding local revenues to carry out municipal projects rather than applying for imperial funding.
5. The possibility of rushed work in an emergency must also not be excluded (cf. n.40). I am not convinced by Rougé's suggestion that 'with the possible exception of the port at Arles, no new ports were built in the Mediterranean during the Roman period, but many existing ports were improved and enlarged': J. Rougé, *Ships and Fleets of the Ancient Mediterranean* (Middletown, CT, 1981), p.173. The point deserves further investigation.
6. P. Pomey and A. Tchernia, 'Le tonnage maximum des navires de commerce romains', *Archaeonautica*, 2 (1978), 233-51; and K. Hopkins, 'Models, Ships and Staples', in P. Garnsey and C.R. Whittaker (eds.), *Trade and Famine in Classical Antiquity* (Cambridge Philol. Soc. Suppl., Vol. 8, 1983), pp.84-109, especially 97-100, plausibly arguing against L. Casson's belief in regular use of very large merchantmen: *Ships and Seamanship in the Ancient World* (Princeton, NJ, 1971), pp.170-73, 183-99. The *Syracusia*, the largest ancient merchantman recorded (Athenaeus, pp.206ff.), proved unusable because 'of all the harbours where it was to call, some could not take the ship at all, and others were risky'.
7. D.J. Blackman, 'Ancient Harbours in the Mediterranean', *International Journal of Nautical Archaeology* (hereafter *IJNA*), 11 (1982), 93 and n.49, 94 and n.52, 97, 204. In this context, W.M. Murray's suggestion of an early date for the first construction of the harbour at Leukas (colonized by Cypselus) is plausible: W.M. Murray, 'The Ancient Harbour Mole at Leukas, Greece', in A. Raban (ed.), 'The Archaeology of Coastal Changes'. Proceedings of the First International Symposium on Harbours, Port Cities, and Coastal Topography, Haifa, 22-29 Sept. 1986 (hereafter Proceedings), BAR International Series (forthcoming).
8. G.E. Rickman, 'Towards a Study of Roman Ports' in Raban (ed.), *Harbour*

Archaeology, p.105.

9. D.J. Blackman, 'The Harbours of Phaselis', *IJNA*, 2 (1973), 360 and Fig. 17; P. Knoblauch in J. Schäfer (ed.), *Phaselis, Istanbul Mitteilungen*, Beiheft 24 (Tübingen, 1981), p.69 and pl. 33.2. The distances between the surviving bollards are irregular: 6.5, 5.8, 2.7, and 3.8 m. (from east to west). Subsequent comments to me on this article tended to support the idea of a connection with careening.
10. Discussion of this point after presentation of the paper confirmed to me the importance of further study of this subject; similar arguments apply to a broken line for the plan of a quay. On Teos see D.J. Blackman, 'Evidence of Sea Level Change in Ancient Harbours and Coastal Installations', in D.J. Blackman (ed.), *Marine Archaeology, Colston Papers*, 23 (London, 1973), pp.115–22, which also discusses Leptis Magna, Terracina, Cnidus, Ostia (Portus) and Naupactus; Blackman, 'Ancient Harbours', 203–4 and nn.100–101.
11. For metal bars set vertically in niches at Ventotene see G. Schmiedt, *Il livello antico del Mar Tirreno* (Florence, 1972), p.180; on rub-marks see Blackman, 'Evidence', 118 (Leptis); for puzzling rub-marks on an upper quay edge (also at Leptis), see *ibid.*, 120. On the Torlonia relief see Lehmann-Hartleben, *Die antiken Hafenanlagen*, Pl. II; Blackman, 'Ancient Harbours', 84, Fig. 2. On metal rings, which also could account for rub-marks, see *ibid.*, n.100; P.F. de C. Williams, 'Roman Harbours', *IJNA*, 5 (1976), 73–9, especially 75–6, which raises a number of points discussed in this paper.
12. D.M. Bailey, 'The Village Priest's Tomb at Aradippou in Cyprus', *British Museum Quarterly*, 11 (1969), 36–58, especially 37–8.
13. V. Karageorghis, *Kition* (London, 1976), pp.17–18; K. Nicolaou, 'The Historical Topography of Kition', *Studies in Mediterranean Archaeology*, 43 (Göteborg, 1976), pp.71–85, especially 81.
14. M. Ohnefalsch-Richter, 'Neue Funde auf Cypern. Die Akropolis von Kition und ein Sanctuarium der syrischen Astarte', *Das Ausland*, 1879, No. 49, 970–74, especially 971. For the record I quote the key paragraph:

Lage und Umgebung der Ruinen beweisen ferner, dass die Akropolis zugleich Hafenburg war. Zum Ueberfluss förderten die Ausgrabungen senkrecht eingelassene Pfeiler von circa 7m Höhe zu Tage; sie stehen vor den Umfassungsmauern und tiefer am ehemaligen Sumpfe selbst; durch die an ihrem oberen Theile horizontal angebrachten groben runden Löcher wurden die Taue gezogen, um die Barken und damaligen kleinen Schiffe zu befestigen; haben wir doch ähnliche Vorrichtungen, wenn auch aus Eisen in unseren modernen Häfen.

Bailey and Nicolaou give the reference to *Das Ausland* but had not seen the article. All recent accounts had overlooked Lehmann-Hartleben, who published a brief summary in his catalogue, with a rather imprecise reference. He also refers to Ohnefalsch-Richter's account in *Unsere Zeit*, 1880, No. 5, 706–7; this lacks the important detail of the height of the 'columns'.

15. For columns with iron mooring rings (Narbo), columns for a roof on a quay (Giannutri), and numbered columns at Portus, see Blackman, 'Ancient Harbours', n.102. Architectural columns have been found re-used as bollards, e.g. at Akko.
16. A. Faber, 'Osor-Apsorus iz aspekta antičkog pomorstva' (Osor-Apsorus from the point-of-view of ancient seafaring), *Diadora*, 9 (Zadar, 1980), 289–316; this interesting report deserves more attention (a summary in German is annexed). The bits are 1.50–2 m. in diameter and 0.80–1 m. tall; a dozen survive, deeply grooved for the mooring rope.
17. Rickman, 'Towards a Study of Roman Ports', 112. The idea of oblique mooring seems to go back to Le Gall. Rougé may be assuming this in his calculations of quay space for 250 and over 200 ships in the Claudian and Trajanic harbours at Portus ('Les ports romains de Méditerranée', *Dossiers de l'Archéologie*, 29 [1978], 14–15). On Cnidus see Blackman, 'Evidence of Sea Level Change', 120; cf. 138–9. The inner side of moles may well have offered mooring space for ships waiting to unload,

while not having sufficient width of quay (if any) for ships to unload directly. Schmiedt argued that broadside mooring would not have been possible against curvilinear quays such as those at Terracina (and some at Leptis Magna): G. Schmiedt, *Atlante aereofotografico delle sedi umane in Italia*, Vol. II (Florence, 1970), *Note introduttive*, p.138. This seems to me to ignore the lines of an ancient merchantman – which was not virtually rectangular like a modern container ship or sheep transporter; Rougé ('Ports romains', pp.18–19) rightly emphasizes the role of small boats in harbour activity. Geoffrey Rickman and Paula Martin, to whom I am most grateful for reading the final draft of this paper, are not convinced that broadside mooring was so obviously preferable in antiquity, as it is now.

18. S.D. Ruegg, 'Minturnae: A Roman River Sea-Port on the Garigliano River, Italy', in Raban (ed.), *Proceedings, BAR, International Series* (forthcoming); Rickman, 'Towards a Study of Roman Ports', 112, following Schmiedt, *Atlante*, II, p.138. On Aquileia see Schmiedt, *ibid*; on Ventotene see Schmiedt, *Livello antico*, pp.177–81.
19. Schmiedt, *Livello antico*, p.177, gives the following distances: mooring bitts K5 to K6, K6 to K7: both c.8.4m.; K4 to K5: 17m.; compare K1 to K3: c.9m. The bitts at the harbour entrance (K9–12) are closer together, but they must be seen in relation to those on the opposite side of the entrance (K13–15).
20. Faber, 'Osor-Apsorus', 301–11, does not provide this information.
21. On Terracina see M.R. de la Blanchère, 'Le port de Terracine', *Mélanges d'archéologie et d'histoire de l'école française de Rome*, I (1881), 335 and pl. XI; Lehmann-Hartleben, *Antike Hafenanlagen*, pp.205–8; other references in Blackman, 'Ancient Harbours', n.100; add Schmiedt, *Atlante* II, p.138. On Rome see Blackman, *ibid.*, Fig. 2 and n.57; Williams, 'Roman Harbours', 75–6; to these should be added the remains of quays found at Pietra Papa, see G. Jacopi, *Bollettino Comunale* (1940), 97; *id.* 'Scavi in prossimità del porto fluviale di S. Paolo, località Pietra Papa', *Monumenti Antichi*, 39 (1943), 45–96, and at S. Passera, see C. Mocchegiani Carpano, 'Rapporto preliminare sulle indagini nel tratto urbano del Tevere', *Rendiconti della Pontificia Accademia Romana di Archeologia*, 48 (1975/76), 239–62. Mocchegiani Carpano likens the remains at Pietra Papa to those at Marmorata, and those at S. Passera to the quays at Aquileia, Leptis Magna (west side) and Claudian Portus (east mole). Only one mooring stone has so far been found at Caesarea, in the Roman quay at I₂; there is a stretch of 12 m. of quay face running south with no further stones. Rougé suggests Trajan's harbour could 'take over 200 ships at its quays' (see n.17 above).
22. On Laurons see S. Ximenes *et al.*, 'Archéologie sous-marine en Provence: le port romain de l'anse des Laurons', *Annales d'histoire, de l'art et d'archéologie*, 7 (1985), 35–46; S. Ximenes and M. Moerman, 'The Roman Harbour of Laurons: Buildings and Structures', in Raban (ed.), *Proceedings, BAR, International Series* (forthcoming).
23. Indications of light booths on the quays were noted at Delos, see J. Paris, 'Contributions à l'étude des ports antiques du monde grec, II. Les établissements maritimes de Delos', *Bulletin de correspondance hellénique*, 40 (1916), 5–73.
24. Vitruvius 10.2.10. Modern references in Blackman, 'Ancient Harbours', n.103; to which add J.G. Landels, *Engineering in the Ancient World* (London, 1978), pp.84–98. Despite his good discussion the exact form of the revolving *carchesia* is not clear. Rougé ('Ports romains', 19) is sceptical about widespread use of cranes.
25. Williams, 'Roman Harbours'; L. Casson, 'Dockside Cranes', *IJNA*, 5 (1976), 345.
26. On Kition see J.-F. Salles, *Les égouts de la ville classique: Kition-Bamboula*, Vol. II (Paris, 1983). On Terracina and Miletus see Lehmann-Hartleben, *Antike Hafenanlagen*, pp.207, 147.
27. See Blackman, 'Ancient Harbours', 204 and n.104. To the sites listed, add the aqueducts at Caesarea and Laurons and the (Late Bronze Age) well and the purple dye factory at Dor.
28. Blackman, 'Ancient Harbours', 194 and nn.74, 77. At Leptis Magna and Ventotene bollards have been suggested as the mooring points, and at Ventotene a

rock-cut cavity as a stowage point for the chain. Schmiedt imagines that the entire chain may have been stowed in the cavity every day, but this seems unlikely (Schmiedt, *Livello antico*, pp.178–9). No evidence of hauling machines (Vitruius' *machinae*) has been found. The relief of 1290 CE showing a chain from tower to tower across the harbour entrance at Porto Pisano is most interesting. The Genoese removed the chain after a victory over Pisa, and later returned it. They also filled the entrance channel with rubble from the demolished towers. See M. Pasquinucci and G. Rossetti, 'The Harbour Infrastructure at Pisa and Porto Pisano from Ancient Times until the Middle Ages' in Raban (ed.), *Proceedings, BAR, International Series* (forthcoming). One wonders whether this effective method of weakening an enemy was used in antiquity.

29. Blackman, 'Ancient Harbours', 189 and n.67; cf. the general discussion, *ibid.*, 188–90.
30. This does not mean, as is often assumed (explicitly or implicitly), that merchantmen were never hauled ashore: note Theophrastus *HP* 5.7.2.
31. Blackman, 'Ancient Harbours', 204–6 and references there.
32. Definite are the 15 shipsheds at Minturnae, though never studied and probably now destroyed: J. Johnson, *Excavations at Minturnae*, Vol. I (Philadelphia, 1935), pp.7, 77; S.D. Ruegg, 'The Underwater Excavation in the Garigliano River: Final Report 1982. The Roman Port and Bridge at Minturnae, Italy', *IJNA*, 12 (1983), 203–18, especially 218. There may have been remains at Centumcellae, now lost: S. Bastianelli, *Centumcellae (Italia Romana)*, Ser. I, Vol. 14 (Rome, 1954), p.40. The pictorial and literary evidence is in any case clear; see Blackman, 'Ancient Harbours', 82–4 and nn.14, 25, 27; 206 and n.112.
33. Doubts are expressed on both these points in an article by V. Foley *et al.*, 'A Trireme Displacement Estimate', *IJNA*, 11 (1982), 305–18. They do not, however, take into account all the evidence available from remains of ancient shipsheds (for example, some recent finds are ignored). They have done a series of friction coefficient tests with wood on wood and wood on stone, with various lubricants, and concluded that wooden skidways would not have been possible on ancient slipways. The completeness of their tests needs to be questioned, however, as well as the conclusions they draw. There are certainly some interesting ideas in their article which need to be checked and developed. Detailed discussion of them was excluded by limitations of time in Caesarea and limitations of space here. The aim of the article was to produce further evidence in support of the case for the 'light trireme'. Unfortunately a key piece of the evidence they adduce is an inscription which is far less complete than they had been told. I am preparing a fuller discussion of their paper.
34. We have a reference to 'drying places by the dockyards' (*psýktras tàs pròs toùs neòrlois*) in a first-century BCE Athenian inscription (*Inscriptiones Graecae* II², 1035, 1.43); I should imagine these to be sites where ships were careened, caulked and pitched. On Sybaris/Thurii see P. Zancani Montuoro, 'Uno scalo navale di Thurii', *Sibari, Thurii, Atti e Memorie della Società Magna Graecia*, (NS), 13–14 (1972–73), 75–9; Blackman, 'Ancient Harbours', 206 and Fig. 12.
35. On Oniadai see Blackman, 'Ancient Harbours', 206; we look forward to further work by W.M. Murray. On Dor and Matala see references in Blackman, 'Ancient Harbours', n.110.
36. On Ventotene compare (a dismal experience) the plans and views in L. Jacono, 'Un porto duomilenario', *Atti del III Congresso nazionale di studi romani, 1933* (Bologna, 1934), Vol. I, Tav. XLVI, Fig. 2, XLVII and Schmiedt, *Livello antico* (1972), pp.176ff.
37. L. Monguilan, 'Géographie commerciale de la Gaule: un port romain dans le golfe de Fos', *Caesarodunum*, 12, Vol. 2 (1977), 359–70; cf. Monguilan *et al.*, 'Dans le golfe de Fos, une nécropole sous la mer', *Archéologia*, 110 (1977), 59–65, especially 60.
38. See n.9 above. Flemming has reminded me of the depressions of ship-like form in the rock at Apollonia – possible evidence of a shipyard. Rougé ('Ports romains', 19) talks of putting ships in dry dock, but what is the evidence?

39. On Building P. see J.W. Shaw, 'At the End of the Road to the Libyan Sea', *Royal Ontario Museum Archaeological Newsletter*, Ser. II, 10 (Sept. 1985); M.C. Shaw, 'Late Minoan I Buildings J/T, and Late Minoan III Buildings N and P at Kommos', *Scripta Mediterranea*, 6 (1985), 19–31. The latest article by J.W. Shaw, which appeared after this paper was given, has left me more convinced: 'Excavations at Kommos (Crete) during 1984–1985', *Hesperia*, 55 (1986), 219–69, especially 255–69.
40. R.L. Hohlfelder, 'Byzantine Coin Finds from the Sea: A Glimpse of Caesarea Maritima's Later History' in Raban (ed.), *Harbour Archaeology*, pp.179–84; cf. Blackman, 'Ancient Harbours', 199 and n.92. The remains of two moles and a quay found by Schäfer, Schläger, and myself at Anthedon in central Greece give every appearance of hasty construction; whether Justinianic or later in date, they provide another good piece of evidence that 'primitive' does not necessarily mean early – an emergency could occur at any time, particularly after the collapse of the *pax Romana*. See articles by R.L. Hohlfelder, pp.54–62 below, and R. Gertwagen, pp. 141–58 below.
41. Rickman, 'Towards a Study'; A.M. McCann, 'The Roman Port and Fishery of Cosa' in Raban (ed.), *Harbour Archaeology*, pp.115–56. Cf. the sensible remarks of Keith Muckelroy in the introduction to his *Maritime Archaeology* (Cambridge, 1978), pp.3ff.