## ΤΟ ΑΡΧΑΙΟ ΛΙΜΑΝΙ ΤΗΣ ΑΜΑΘΟΥΝΤΑΣ

(Περίληψη)

Το αρχαίο λιμάνι της Αμαθούντας ήταν το αντικείμενο τριών υποβρυχίων αρχαιολογικών ανασκαφών, από το 1984 έως το 1986. Αυτή η επιχείρηση, που χρηματοδοτήθηκε από το ΣΑΛΠΑ (Σύλλογος Αναβίωσης Λιμένος Παλαιάς Αμαθούντος) και τη Γαλλική Αρχαιολογική Σχολή Αθηνών, απασχόλησε περίπου είκοσι δύτες, κατά μέσον όρο, που υπολογίζεται ότι έκαναν παραπάνω από 3.000 καταδύσεις με περισσότερες από 7.500 ώρες εργασίας κάτω από το νερό —μια επιχείρηση που διήρκεσε συνολικά περισσότερο από 6 μήνες. Η Εθνική Φρουρά μας συνέδραμε διαθέτοντάς μας αρκετούς δύτες, και η RAF, εκτός από τον πεπιεσμένο αέρα για τους ανθρώπους και τις συσκευές, μας επέτρεψε την εναέρια λήψη φωτογραφιών της τοποθεσίας με ελικόπτερο, που κατέληξε σ' ένα σχεδιάγραμμα, βασισμένο σε εναέρια φωτογραμμετρία.

Η ανασκαφή περιλάμβανε τριάντα περίπου τομές κατά μήκος των κυματοθραυστών και του πυθμένα του λιμανιού με τη βοήθεια δύο εξεδρών, όπου ήσαν εγκατεστημένα τα μηχανήματα (συμπιεστές, αναρροφητές, κ.λπ.).

Το σχήμα του λιμανιού είναι ορθογώνιο και ορίζεται από δύο γωνιαίους κυματοθραύστες, περίπου 100μ. Β και Ν και 180 Α και Δ. Η είσοδός του, μήκους 20μ. περίπου, βρίσκεται στη ΝΑ γωνία, προφυλαγμένη από τους ισχυρούς ανέμους. Οι δόμοι προέρχονται από τα λατομεία, που ξαναβρέθηκαν στην ακρογιαλιά, και μεταφέρονταν έως το σημείο όπου βρισκόταν με ένα μηχάνημα πάνω σε καρούλια. Το μηχάνημα ανύψωνε τους δόμους και τους τοποθετούσε απευθείας στο βυθό, προχωρώντας αντίστοιχα με τις εργασίες του κυματοθραύστη. Επρόκειτο για ένα μηχάνημα πολύ ισχυρό, αφού ορισμένοι δόμοι ξεπερνούσαν τους 3 τόνους, έχοντας πλάτος μεγαλύτερο από 3μ. και πάχος 0.70μ.

Οι αγκώνες στις δύο άκρες κάθε δόμου χρησίμευαν για να περνάει το σχοινί, για την τοποθέτηση των δόμων στον πυθμένα. Ο αριθμός αυτών των δόμων είναι αξιοσημείωτος, γιατί ανέρχεται σε αρκετές χιλιάδες: διατηρούνται ακόμη σε 7 στρώσεις (τουλάχιστον 1 στρώση έχει χαθεί). Αυτοί οι δόμοι αποτελούσαν την εσωτερική πλευρά της αποβάθρας: συγκρατούσαν μια μεγάλη εξέδρα, που προστατευόταν από τη μεριά της θάλασσας μ' ένα κυματοθραύστη από τεράστιους δόμους αδρά λαξευμένων βράχων.

Κανένα αρχαίο κείμενο δεν αναφέρει την κατασκευή του λιμανιού της Αμαθούντος. Η ιστορία του ήταν ασφαλώς σύντομη: κατασκευάστηκε εσπευσμένα και εγκαταλείφθηκε λίγο αργότερα, πιθανόν πριν αποπερατωθεί. Το συμπέρασμα αυτό εξάγεται από την άφθονη ομοιογενή κεραμική, που συλλέχθηκε κατά μήκος των κάτω σειρών, και επιτρέπει να χρονολογηθεί η κατασκευή του λιμανιού από τα τέλη του 4ου αι. π.Χ. έως την εποχή που ο Δημήτριος ο Πολιορκητής με το στόλο του κατόρθωσε να αποσπάσει την Κύπρο από τον Πτολεμαίο Σωτήρα. Πιθανόν ο Δημήτριος σκόπευε να εγκαθιδρύσει εδώ μια ισχυρή βάση για να απειλεί τις υπόλοιπες κτήσεις του εχθρού του. Αφότου πάντως ο Πτολεμαίος ξανάγινε κύριος του νησιού το 294 π.Χ. το λιμάνι δεν ήταν σε χρήση και έκτοτε δεν σύχναζαν εκεί παρά μόνο τα αλιευτικά πλοιάρια.

# The Heritage of Ancient Harbour Engineering in Cyprus and the Levant

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## Foreword

The study of ancient harbours is still in its initial phase, and is a rather complicated and very often frustrating issue. Yet much progress has been made during the last decade. The state of research, as summarised in the early 1980's (Blackman 1982) is no longer valid. Not a single reference can be found there concerning Cyprus, other than to mention that "It has also been suggested that some of the earliest artificial harbours may be found in Cyprus" (*ibid.*, 92). This paper will not pretend to give a complete up-date of the current state of affairs in this field. Instead, it will try to present a representative picture of what is hither – to known about ancient harbour technologies in relation to maritime demands, the given topographic features, the understanding of coastal processes, and contemporary building technologies. However, before delving into that rather ambitious topic, it is necessary to set forward some preliminary assumptions:

1. Harbours, havens and anchorages of every type and technical quality are located at the water-line. The water-line is in a constant state of flux: almost everywhere along the east Mediterranean seaboard, the present waterfront is not the same as in the past, and it will change again in the future. For this reason, the search for ancient harbours must take into account the study of coastal changes, palaeotopography and the nature of the coastal processes which prevail in any given site at any given period.
2. One must give credit to the ancients for being as observant and experienced, if not more so, as we are today. Thus, phrases such as "proto-harbours" (see H. Frost, this volume) or "rock-cut Bronze Age havens" (Blackman 1982, 92), should be considered bias statements on the state of our knowledge, and not necessarily that of the ancients.
3. The level of demand dictates the quality of a product and the amount of resources which will be invested in its construction and maintenance. In the case of harbours built on ever-changing sites and which were functional over long periods of time, the question whether such a level of demand did continue is seldom considered. For these reasons, one may assume that throughout the history of maritime activity first-class, full-scale harbours, which functioned all year round, were few and far between, though not because of a lack of technical know-how.
4. The technical demands of a naval base were (and still are) radically different from those of a commercial harbour, and so might be located in a different type of site, with different structural features (Carmon 1985). The main function of each type of harbour therefore needs to be studied, to better understand its location, the actual harbour site and its features, as well as its fore- and hinterland. Specialized harbours have existed since the earliest maritime endeavours (specifically to handle ores, passengers, grain, bulk cargo, and for transit, etc.) and were fashioned to fit their special function.
5. In the Levant and on Cyprus there are only a few naturally fitted topographic features which are suitable as proper havens. Thus the same locations have been used time and

again, throughout the ages, unless topographical changes, either man-made or naturally-induced, made them unsuitable. Therefore, one should look for better preserved ancient harbours which have not been built over, notwithstanding their present suitability or otherwise as sea havens.

## 1. Geographical Background

There are several common geographical features characteristic of both the Levantine and Cypriot coastlines, which should be considered in a study of maritime activity throughout the ages. These are:

*a.* A rarity of natural havens. Most of the coast is delineated by either hilly ridges or a chain of mountains parallel to the shore, and there are only a few rather flat valleys. There are only few near-shore islets, and there are no deep water inlets or fully protected bays.

*b.* Not many river outlets have a significant perennial flow. Most outlets are characterized by a gushing flow during the winter rainstorms, which carries masses of sediment down to the coastal plain and to the shallower part of the continental shelf. This soon dwindles and eventually dries up during the long summer drought. During the period of drought breaker-deposited sand often completely blocks the outlets.

*c.* There is only a minimal tidal gauge of an amplitude of less than half a metre. This is exacerbated by silting-up of the river outlets and estuaries, and creates a continuous line of beaches within a relatively short time after the sea level has reached a stable elevation. The rate of silting is affected by climatic changes and by the density and intensity of the vegetation covering at the watersheds of the rivers. Man's deforestation and desertification (by overgrazing, ploughing, etc.) might intensify silting down stream and at the estuaries.

*d.* Almost nowhere along these coasts is there a sudden drop in the sea floor adjacent to the shore line. Instead, the continental shelf slopes rather gently, allowing the accumulation of sediments. This is true to a certain degree almost everywhere, except along the northern coast of Cyprus, to the east and west of Morphou Bay, and in places along the northern coast of Syria. This, together with the occurrence of several large bays and headlands, facilitates a variety of temporary off-shore anchorages for ships of all sizes, on the lee side of seasonal winds.

*e.* Seasonal weather and wave climate are similar along the Levantine coast and the southwestern coast of Cyprus, though differences are noted for the seasonally calmer seas along the south and southwest of the island during the summer.

*f.* The wind pattern in the area is such that during the more even season, which is better suited for sailing under a square rig, in the summer months it is very hard to sail directly westwards, or even to the northwest. For this reason, navigational courses were indirect, with a counter-clockwise trend. Cyprus would be reached from the Nile Valley and the southern coast of the Levant by a route along the Levantine coast with a short crossing from north Syria, or the Bay of Antioch. This crossing could be made easily within less than a day's sailing in both directions. Sailing north and west from Cyprus, towards Anatolia and the Aegean would have been riskier, and more complicated to predict. It was sometimes safer to sail eastward from the eastern, or even from the southern coast of Cyprus, to the Syrian coast, and from there to follow the south coast of Anatolia all the way to the Aegean. A crossing using the direct route between Cyprus and Crete could have been made during the less predictable weather of early summer and autumn, but it was much easier in the other direction (see Lambrou-Phillipson 1991 and Murray, this volume).



## 2. Regional and Local Changes of the Coastline

This is probably the most complicated issue in the study of ancient harbour installations. One would like to know where and at what absolute altitude the sea level was at a certain location during a particular era. So far, at best, the present state of research can only suggest whether a particular site is part of a region that has either subsided, been uplifted, or has remained relatively stable. These terms, usually referring to regional displacement, derive from plate tectonics. Such displacement though, can hardly be distinguished from isostatic and eustatic changes in sea levels (Pirazzoli 1987).

The best database presently available for the Mediterranean suggests a tectonically stable situation for the Levantine coast: with slight subsidence at a rate of less than half a metre in 2,000 years for the southern part, and even less uplift in the north (between Arwad and Ras Basit). For Cyprus there is a more complicated model: with zero displacement along the north coast and around Cape Kiti, and increasing subsidence towards the southwest, the maximum being 1m. every 1,000 years (at Akrotiri and Kourion), and also to the northwest (with a similar maximum around Salamis) (Flemming and Webb 1986, 21). Unfortunately, these models are based on rather limited data, comprising, almost exclusively, archaeological benchmarks. They have been interpreted by geologists, who have not always had the opportunity to visit every site and examine the validity of the information, so as to substantiate their interpretation.

More in-depth, detailed research may prove that such an overall model is irrelevant when studying a single site. As an example we submit the reconstructed graph of vertical changes in land/sea relations for Dor, a coastal site with over 5,000 years of occupation, in the southern Levant (Fig. 1). Similar studies have been carried out at some sites on Cyprus: the more thorough one around Larnaca (Nicolaou 1976; Gifford 1978; 1986; Collombier 1987), with other, preliminary surveys at Salamis (Flemming 1974) and Amathus (Empereur and Verlinden 1987). Along the northern Levantine coast (Syria and the Lebanon) geological surveys have been carried out in the 1960's, but only a few of these were accompanied by archaeological excavation (Sanlaville 1970; Frost 1973). The study of the Israeli coast is somewhat more advance, though to date no overall, comprehensive report has been published (Flemming *et al.* 1978 lacks the most recently acquired data, see below).

Lateral displacement of the coastline has an even greater influence on harbour installations than does vertical displacement. The seafloor gradient is just over 1% off the shore of Larnaca, and is practically zero at its coastal plain and at the lower marshes, north of the town. Consequently, every fluctuation of the sea level (e.g., the erosive base) would dramatically improve the coastal drainage. Yet a rise of only 1m. or so would renovate the marine lagoons to the north and south of the city, at least until the waves would rebuild the harmonic arc of the coastal berm. The same phenomenon is relevant to most of the ancient harbour sites on Cyprus and in the Levant. No wonder it is so costly to build deep water, commercial harbours at Larnaca, Limassol and Ashdod.

Before returning to the harbours of antiquity, we should remember that until recently, up to the beginning of the 20th century, there was no year-round, deep water haven available for full-scale steamers, either on Cyprus or in the Levant (Hill 1972, 11).

## 3. Bronze Age Harbours

Maritime trade might have begun some time during the Neolithic period. From these early times we have evidence for obsidian of West Anatolian and Aegean origin at Levantine

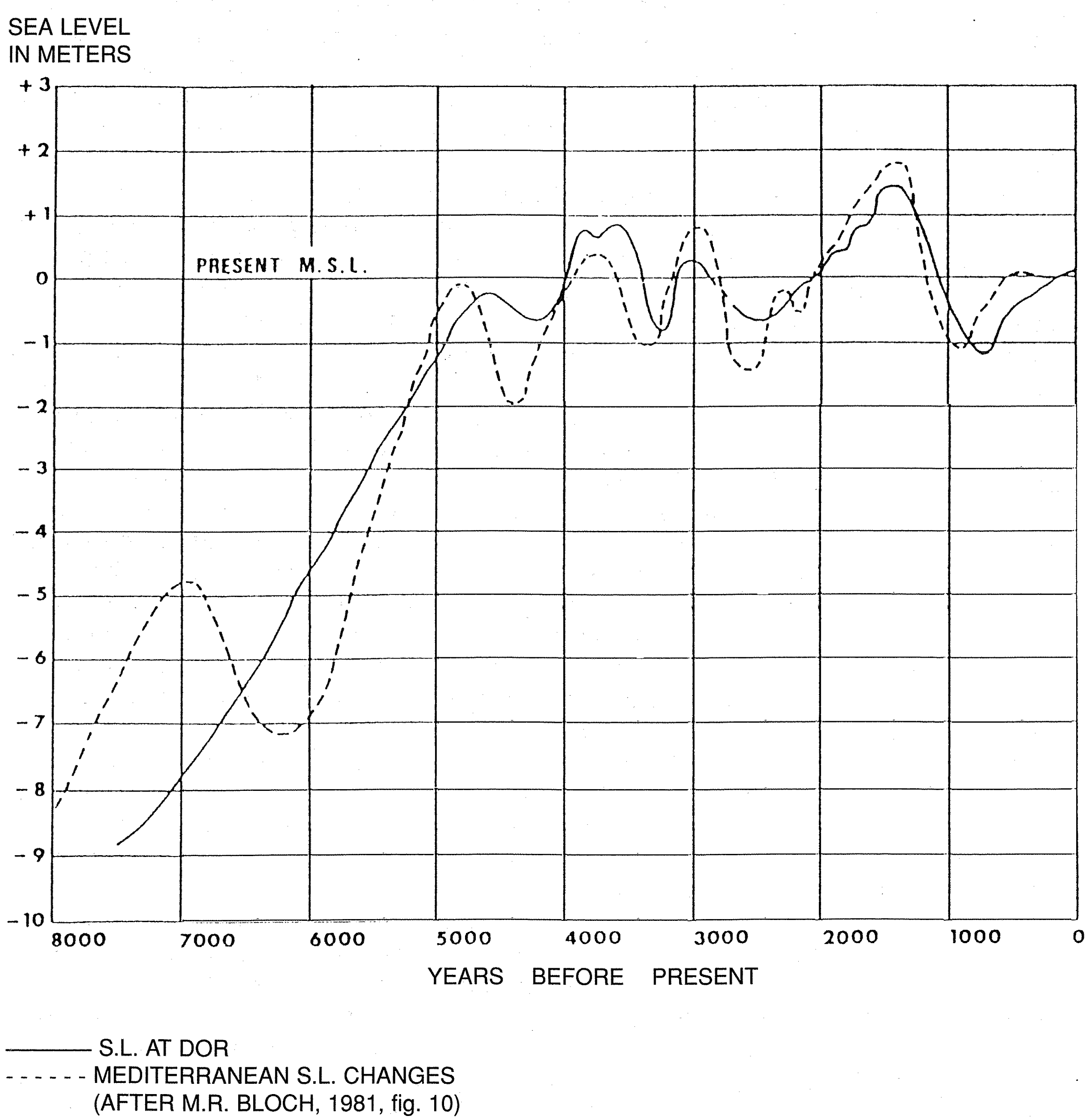


Fig. 1. Reconstructed changes of the sea level at Dor, Israel, during the later Holocene.



coastal sites. Cyprus was settled during that period by people who came by sea, probably from the southeast. Unfortunately, not much is known about the landfall settlements of this early period, when the sea level was much lower than it is at present, and the configuration of the coastline was entirely different (see Masters and Flemming 1983, 601-30; Raban 1983; Galili 1987). Since there is no available information concerning the topographical features of the neolithic coastline, either for Cyprus or the Levant, and as there is no evidence for large cargo vessels and bulk sea-borne trade prior to the EBA, nothing can be said about the havens, anchorages, or harbours, and whether there was, already, need for them (see Raban 1985, 12-4).

If there were any artificially accommodated havens in Cyprus during the EBA, one might look for them along the north coast and Karpasia, considering the archaeological evidence there for connections beween Cyprus and Anatolia throughout much of that period. Towards the end of the 3rd millennium B.C.E. (EC III), there is evidence for imports from Syro-Palestine, Egypt and Crete. Yet these rather scanty finds may have reached Cyprus indirectly, via Cilicia, Byblos, or Ugarit. Thus far, no EC artifacts have been found on EBA sites in the Levant.

The picture is a little more informative in the search for EBA harbours along the Levantine coast. There are ample historical and archaeological data to illustrate the importance of Byblos as a major maritime base for trade with the Nile Valley, from the beginning of the Dynastic period in Egypt. Quantities of commercial jars from Cilicia and Syria, found in Old Kingdom tombs at the cemetery of Giza, may indicate that sea-borne trade of bulk cargo may have existed already early in the 3rd millennium B.C.E. (Reisner and Smith 1955). Inscribed jars of the 2nd Dynasty, found at Abydos, and the 4th Dynasty "Palermo Stone" of Snefru, which records "40 ships filled with cedar logs" being "100 cubits long" (Prifchard 1955, 227), are probably only the tip of the iceberg of well-attested maritime shipment of bulky staple commodities. Such activity almost certainly would necessitate ample harbour facilities at both ends of the maritime trade route.

Ugarit, and perhaps some other north Syrian coastal cities, are possible EBA harbour sites. Yet, at all these sites, archaeology has not been able to locate the whereabouts of the actual maritime facilities of that early, urban phase. It is quite probable that if they did exist (which seems to be the case) they are to be found in presently submerged areas, in silted-up lagoons, or under later installations.

South of the Syrian coast only one EBA large-scale city port has been identified thus far: Ashkelon, on the south coast of Israel. Recent excavations there have exposed major fortifications by the sea, but so far there are no indications as to the whereabouts of the port itself, either for the EBA or for any later period of the city's history. Yet, unpublished, geomorphological studies, carried out by the Center for Maritime Studies at the University of Haifa on behalf of L. Stager of Harvard University, suggest a radical change in land/sea relations at Ashkelon during the historical era, and the probable existence of an active fault-line along the 1300m. long water-front of the site: the land was being up-lifted whilst the sea floor subsided at a rate of 4-6m. (see Fig. 2).

Turning to the MBA, around 2000 B.C.E., the picture along the Levantine coast is entirely different. Within less than two centuries there are dozens of newly established coastal, urban settlements, all in locations closely connected to river outlets, or somewhat upstream on the coastal plain. It has been suggested that this well-documented process of coastal urbanism was initiated by immigrants from the north (the Syrian coast), and was facilitated by marine transgression towards the end of the EBA (see Raban 1985, 11-2; 1987a; 1991,

Fig. 2. The sea shore at Tel Ashkelon, looking southwest.

136-40 with additional bibliography). This alleged, rapid transgression (the latest documented one in the Levant) flooded the river outlets and much of the lower basins on the coastal plain, creating a series of estuaries and marine lagoons, and an almost unlimited variety of naturally safe havens with good accessibility to the hinterland.

This favourable situation could not last long unless the inhabitants took preventive measures, such as building earthworks. Otherwise, the affected drainage system of the uplifted erosive base, and the longshore, current-carried Nile sand (Carmel *et al.* 1985) would soon choke off these navigable basins, both from within (by river sediments) and from without (by sand spits and coastal berms). One harbour site where it has been proven that such measures were undertaken is Akhziv, on the north coast of Israel (Fig. 3).

At Akhziv, during the MB IIa period, shortly after 2000 B.C.E., the first urban settlement was established on what was then a rocky peninsula, on the northwest side of the estuary of the largest river of western Galilee, the Keziv. This estuary enabled marine vessels to sail in and moor (probably next to a stone-built quay) on the lee side of the eastern city wall. Yet, it must have soon become apparent that this haven had to be constantly dredged, or altered so as to overcome the rapid silting of the mooring basin and the opening to the sea. We shall never know whether dredging was ever attempted, and if so, by what means and for how long. The inhabitants eventually sought a more radical and less Sisyphean solution. First, they used earth dams to block the river's natural course just above the anchorage. Then they cut an alternative course across the low, rocky saddle, for the river's outlet (in Fig. 3, note the uninterrupted ridge in the water, opposite the present outlet), so that the winter floods would carry the river's load upstream from the harbour's entrance.



Excavations on the eastern side of the MB settlement show that some of the rampart comprises sediments quarried from the dredged mooring basin (Prausnitz 1975). Maintaining the navigation channel which connected the mooring basin with the sea was more of a problem. It seems that the natural process of beach formation, by wave-carried sand, could not prevented. Thus, it was circumvented through an alternative 6m. wide artificial navigation channel, cut through the rock to the north of the sand berm, behind the reefs of the abrasive shelf (Fig. 4).

Another type of MB IIa maritime installation has been found at Tel Dor. This site, located on the southern part of Mount Carmel's coast, was also a rocky peninsular formation, on the northernmost reaches of the Dalia's estuary (Fig. 5). By the time it was settled during the MBA, the topography offered three alternatives for havens: at the lagoon on the lee side of the coastal ridge; in the protected body of seawater behind the line of inshore islets to the south (Tantura lagoon); and at "Love Bay", a well-protected and rather small bay within the city walls (Fig. 6). Excavations carried out on land, in the inner part of that bay, by the present author on behalf of Prof. E. Stern of the Hebrew University, have revealed a massive wall of roughly squared, gigantic blocks of local sandstone. These were laid at the waterfront, with a base course of headers (Fig. 7). Stratified marine deposits behind the wall, or quay, have been positively dated to just before 1800 B.C.E. (Raban and Galili 1985, 334-9).

One might wonder whether such man-altered estuaries and coastal lagoons, with additional stone-built quays, seawalls or landing stages, like those also found at Tel Nami and in Middle Minoan Crete (Raban 1991), were not also the base for other sea-borne trade centres. On Cyprus these might include Enkomi, on the common estuary of the Pediaeos and the Yialias (Collombier 1987, 168-9), Hala Sultan Tekke (Karageorghis 1968, 10), Arpera, on the estuary of the Termithios (see Merrillees 1974, 59, for MB IIa Canaanite jars found there), Toumba tou Skourou, Maroni and others (for full discussion, see Catling 1962).

Since none of the alleged Bronze Age haven sites have yet been properly studied, no suggestions can be made as to a model for their technology, or for the "proto-harbours", quarried basins, or "cothons" (whatever this might mean, beyond being one of the harbour basins of Carthage; see Blackman 1982, 90-4; Frost, this volume). From the few examples discussed above and others discussed elsewhere (Raban 1985; Shaw 1990) one can conclude only that Bronze Age harbours should be looked for and studied with reference to Bronze Age topography, and that so far we know of no artificial moles or man-made breakwaters from that period, either on Cyprus or in the Levant. We do not even know if their basins were incorporated within the city walls, wherever such walls existed.

Yet, when dealing with the LBA we have some textual documentation which suggests that at least some of the Canaanite harbours had a controlled entrance; and a few may have served as naval bases for military fleets (Linder 1973). The radical change in the importance of Cyprus as a source of timber, copper and agricultural products for Egypt, the Hittite empire, the Levant and the Aegean (see Karageorghis in this volume) might have justified proper harbour installations and maintenance to facilitate the shipment of these commodities. It seems as if the preferred sites for these export centres were selected according to the topography of the foreland: for example, the eastern coast of Cyprus, though at a distance from the Troodos massive with its ores and long timbres, was better suited for sea borne trade with Byblos, Ugarit and other emporia on the northern Levantine coast. These ports might also have served, either directly or indirectly, the Aegean ports-of-call, and even Crete (Lambrou-Phillipson 1991, 14). Other ports serving trade with Egypt may have been

Fig. 3. Aerial photograph of Tel Akhziv with the ancient estuary delineated.

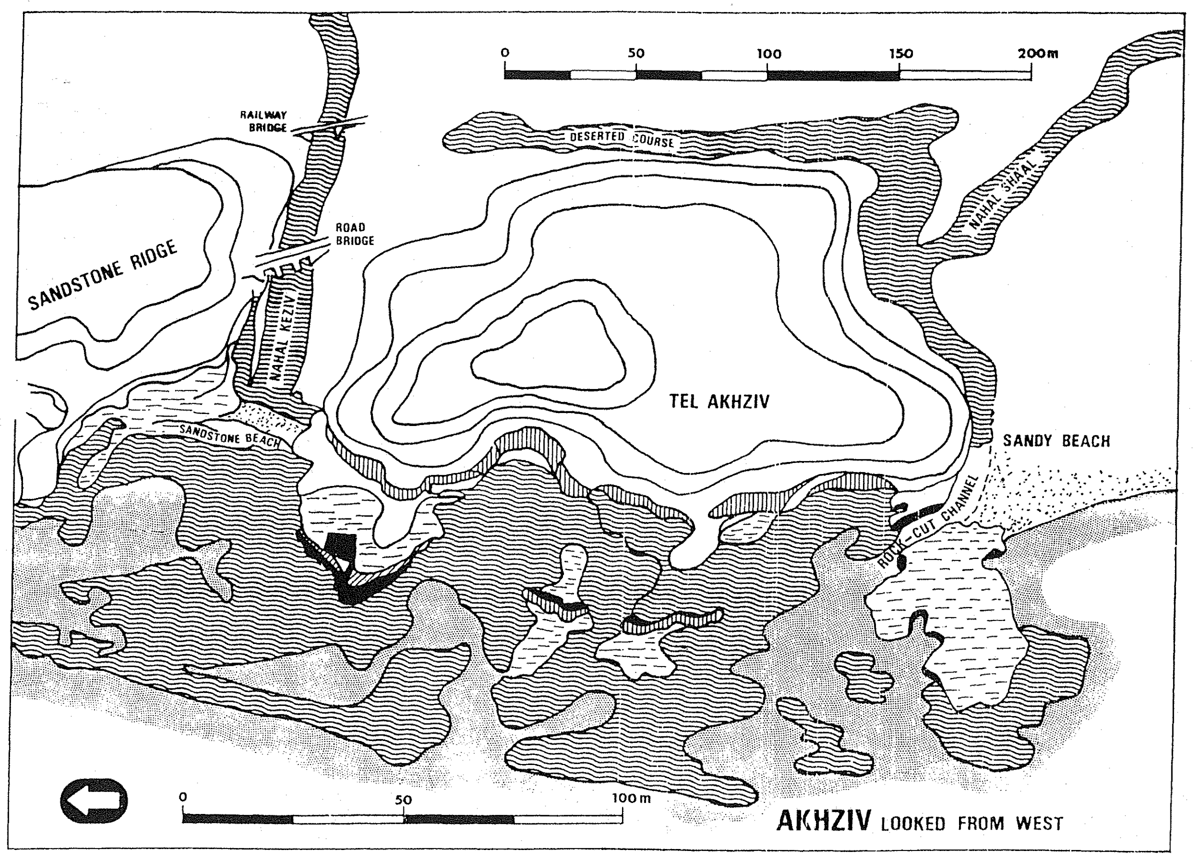


Fig. 4. Sketch plan of Akhziv in the MB II period.



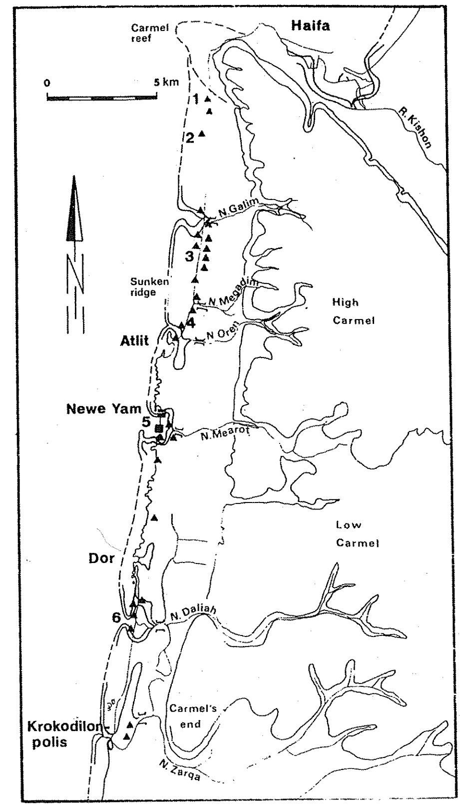


Fig. 5. Sketch map of the Carmel coast as it was *ca.* 2000 B.E.C.

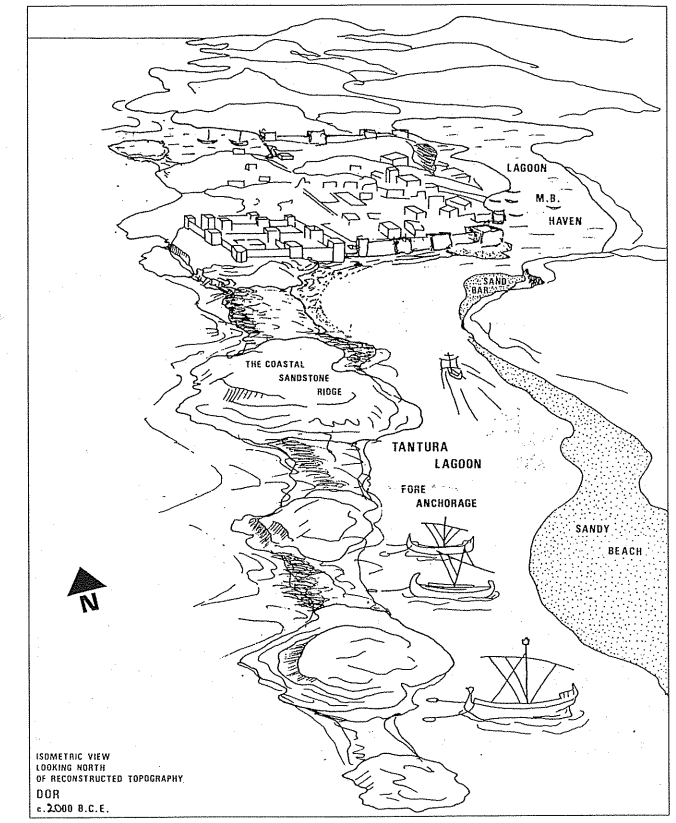


Fig. 6. Reconstructed isometric view of Dor's coast *ca.* 1800 B.C.E.

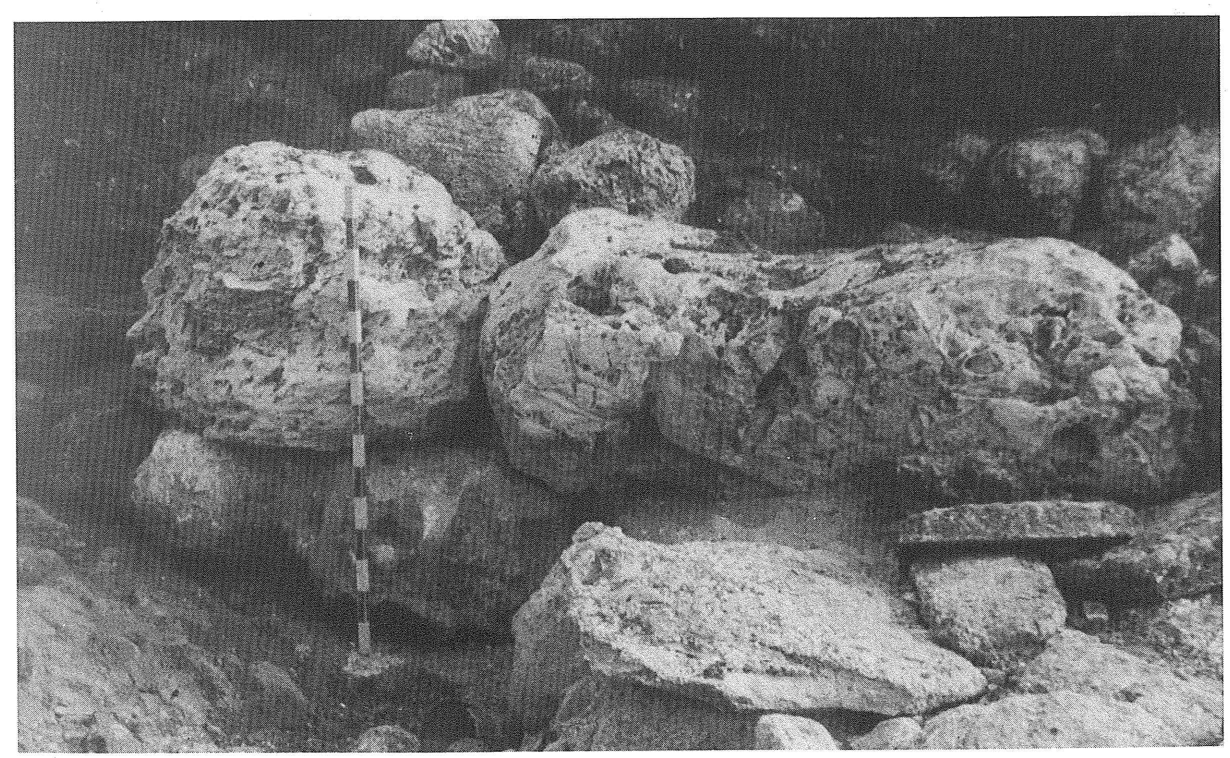

Fig. 7. The MB IIa seawall at "Love Bay" in Dor, looking east.

located on the south coast of Cyprus at the outlet of Vasilikos and on the southwest, at Kouklia and at the outlet of the Ezousa River.

In the Levant we may mention the bay harbours (?) of Minet el Beida (Ugarit) with its seawalls of ashlar headers (Schaeffer 1937, 135-7, Figs 5,6) Byblos and Akko (Raban 1991a); the offshore harbour on the lee of rocky islets as in Tyre, Sidon and Arward (Frost 1973); and the improved MB II estuarian harbours (usually in connection with a nearby in-shore islets), as in Sidon, Tel Nami (Artzy 1990; Artzy and Marcus 1991) and Dor. At this last site we have the best preserved architectural features for the later part of the LB period, with some parallels for Ugarit, Ras Ibn Hani, Kition, Hala Sultan Tekke and Enkomi (Lagarce 1986).

By the 14th century B.C.E. it seems that the lagoon at the eastern side of Tel Dor (Fig. 6) had already silted up and the waterfront had to be built at the south side, on the northernmost end of the Tantura lagoon (Fig. 9). At that point the archaeological studies exposed a series of repeating quays, or ashlar-built landing stages. The earliest was built during the latter part of the 14th or the early part of the 13th century B.C.E. (Raban 1983a, 229-41). This quay comprised a platform about 50m. long and 10-12m. wide, paved with 5-6 rows of rectangular slabs (Fig. 10), flanked on both sides by bastions of huge headers (3×1.5×1.5m.). The western one of the west incorporated a rectangular, ashlar-lined well that had been dug into the sandstone bedrock to exploit the shallow water-table at the interface with the seawater (Figs 11, 12). Probes around the quay indicate that, at the time when it was built, the present-day bay was still detached from the sea to the west and was open to the lagoon on the south, and that the sea level was lower than at present by more than half a metre. The sedimentological study of natural (wave-borne) deposits in the stratigraphical context of the quay, and of the three successive ones which replaced it during the next 150-200 years, indicates that during this period the sea level gradually rose to an elevation well above the present one (a total rise of over 1m.). Thus, the later quays were placed on higher ground, to accommodate the altered interface (see Fig. 1 and Raban 1983a, 232-3).

The most interesting parallel to these quays are the so-called "Bastions" which were exposed along the outside of the earliest, Cyclopean wall at Kition-*Kathari*. These bastions were interpreted as parts of either the Cyclopean or the earlier brick wall (Karageorghis 1967, 315-24). I am still under the impression, however, (having visited the site during the excavations in 1971) that these two rectangular structures, which face the lagoon to the north and are topped by a unique type of scarfed corner slab, were originally free-standing quays established at the artificially scarped edge of the marine lagoon, the inner harbour of Kition (Figs 14, 15). These closely resemble in shape, dimensions and components, the quay of the third phase at Dor (Figs 16, 17). There is also a close resemblance between the rectangular well at Dor and ashlar paved basins at Hala Sultan Tekke (Hult 1978, 6, 8, 14) and Enkomi (Fig. 18). That the early 12th century B.C.E. quay at Dor has been attributed to the "Sea Peoples" is well attested (Raban 1987). Together with its close parallels in Cyprus and along the north Syrian coast, this would appear to support the premise that the new settlers from the west contributed to maritime technical know-how during this period (Raban 1983a, 238-41; 1988a).

As for understanding coastal processes, the "Sea People" settlers at Dor seem to have been aware of the excessive silting of their haven following the marine transgression. To avoid this they cut a flushing passage across the rocky reef which until then blocked the western side of the bay (see Fig. 9).



Fig. 8. Oblique aerial view of Byblos.

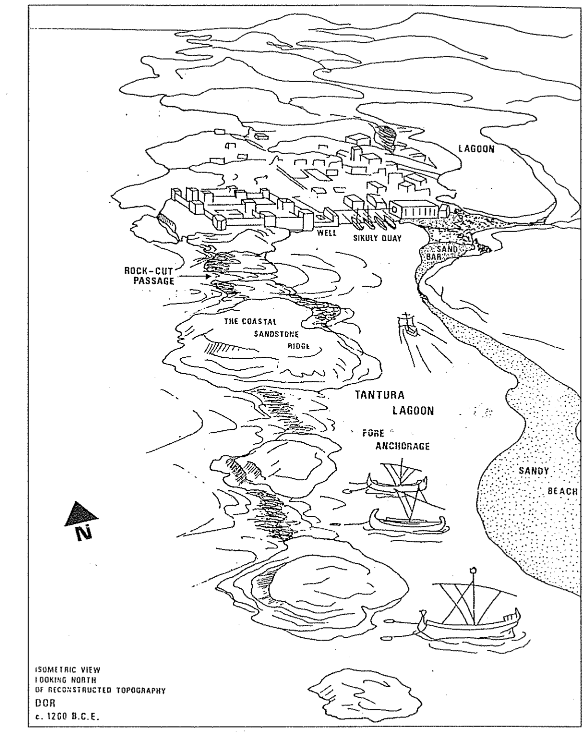


Fig. 9. Reconstructed isometric view of Dor's coast *ca.* 1200 B.C.E.

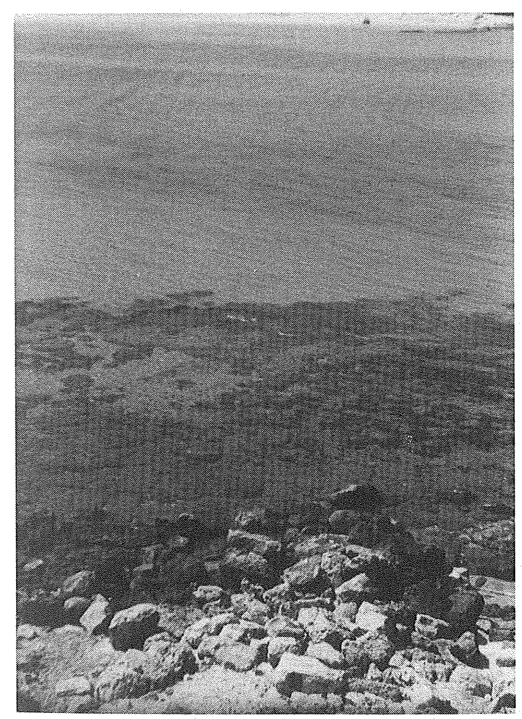

Fig. 10. View over the submerged LBA quay at Dor, looking south, toward the Tantura lagoon.

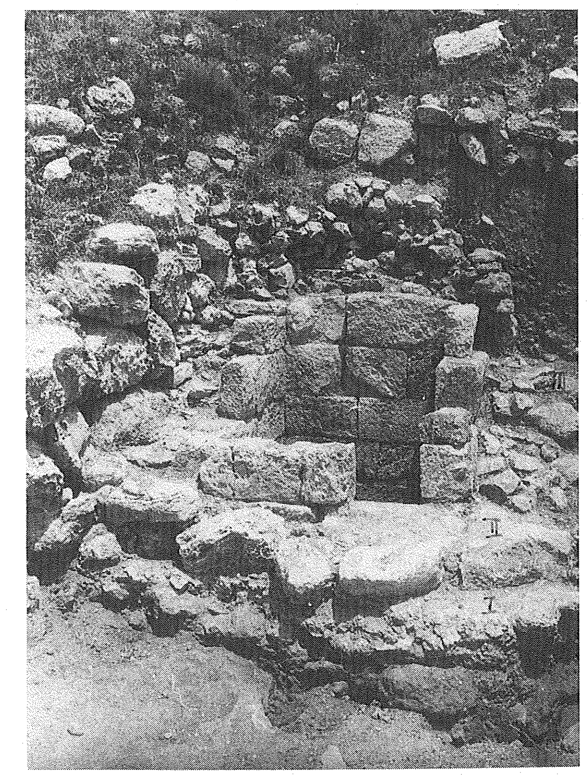

Fig. 12. The rectangular well near the coast at Dor, from the south.

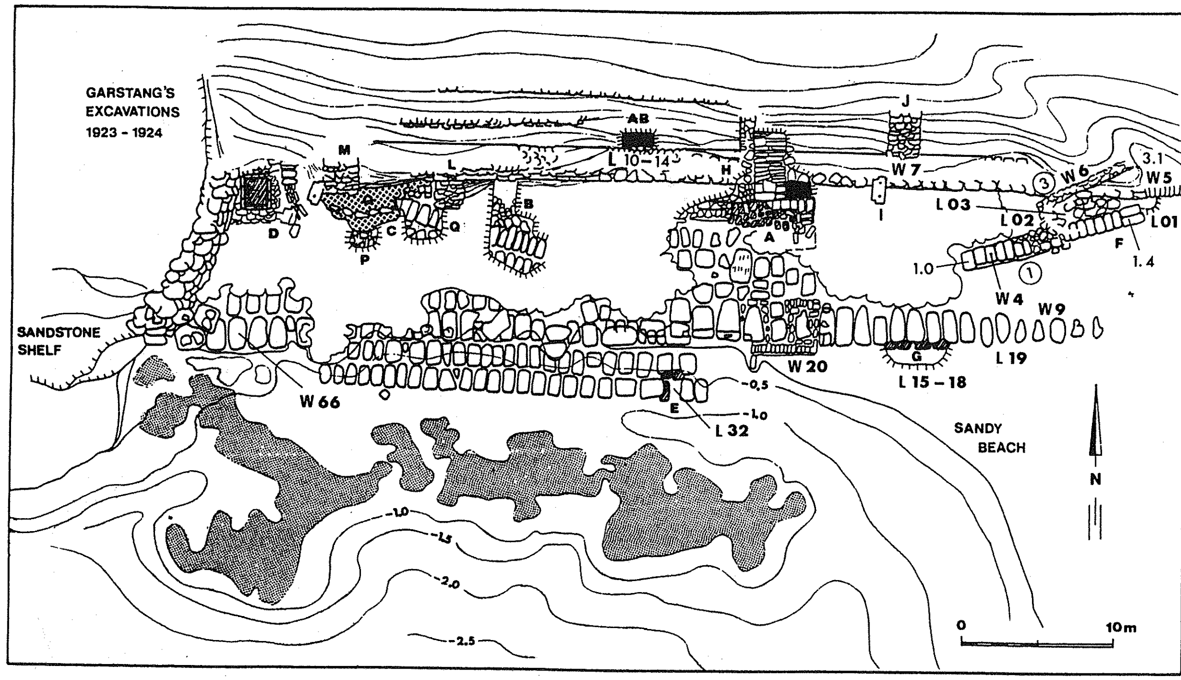


Fig. 11. Plan of the various quays along the shore line on the southeastern side of Tel Dor.

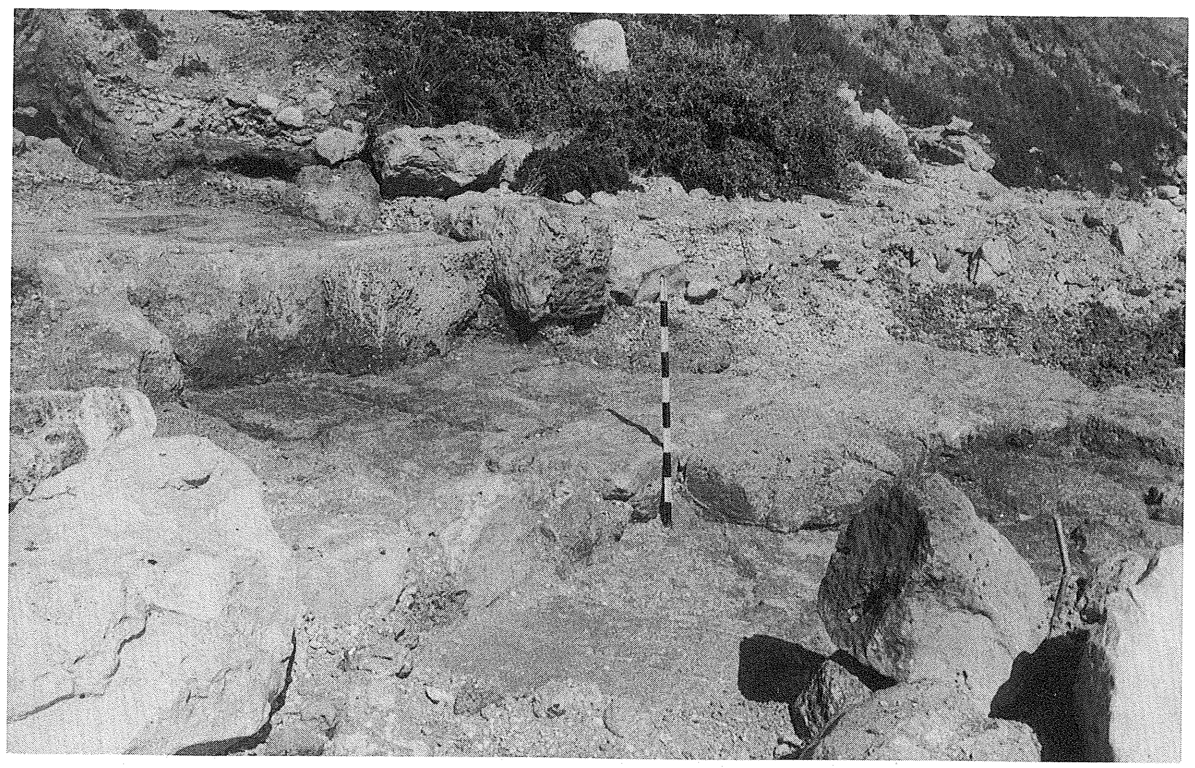

Fig. 13. The surface of quays 2 and 3 at Dor, looking east.



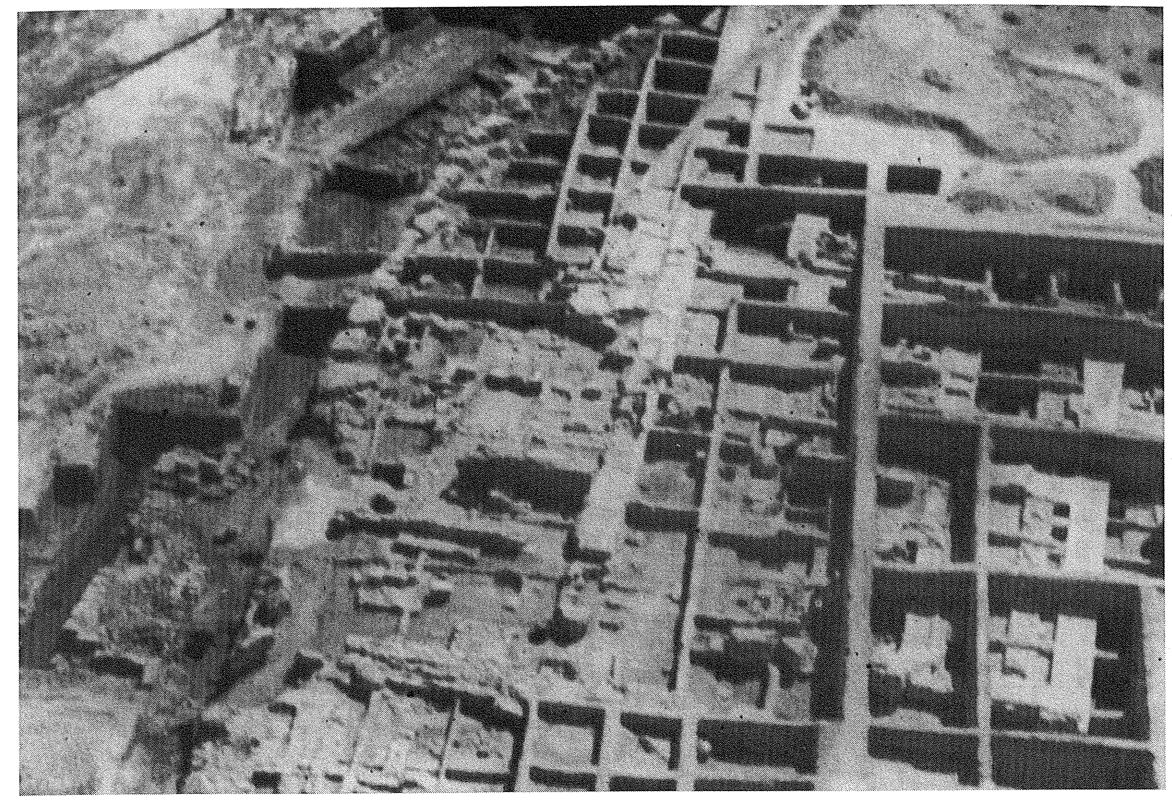

Fig. 14. Aerial photograph of Area II at Kition during the excavations.

Fig. 15. The north wall at *Kathari* and the topping slabs of its "Bastions", looking east.

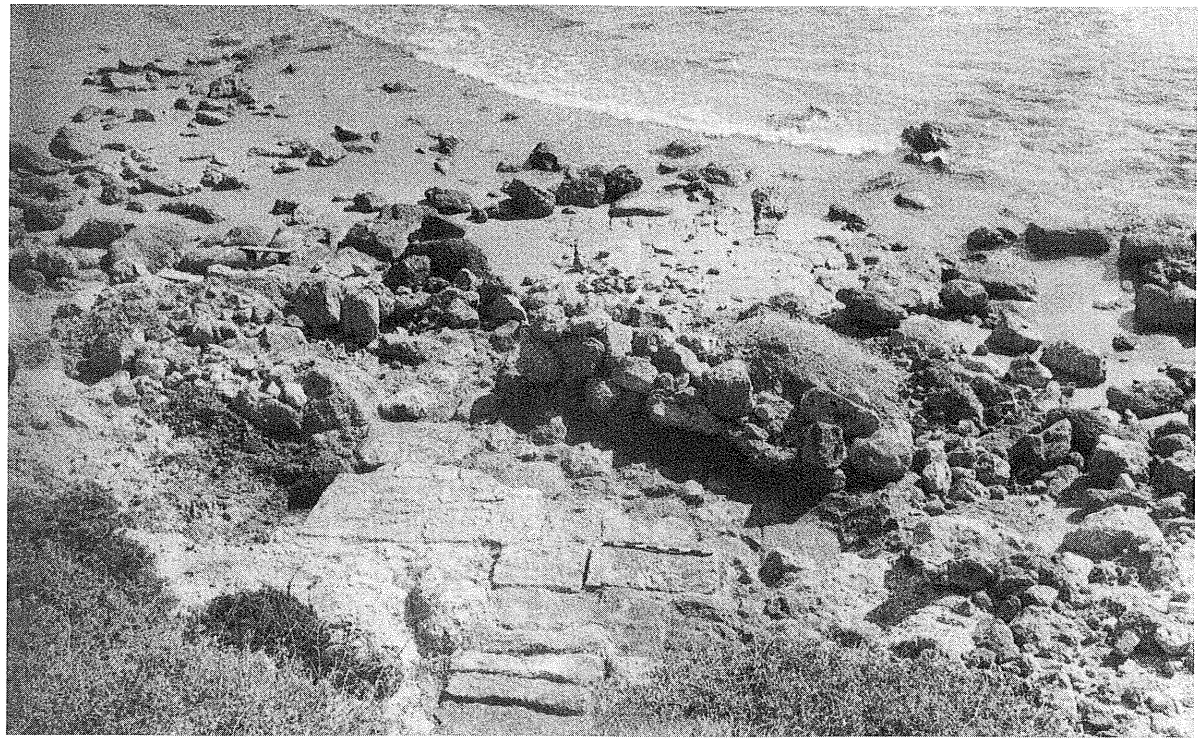

Fig. 16. Part of the quay of the third phase of Dor, looking south.

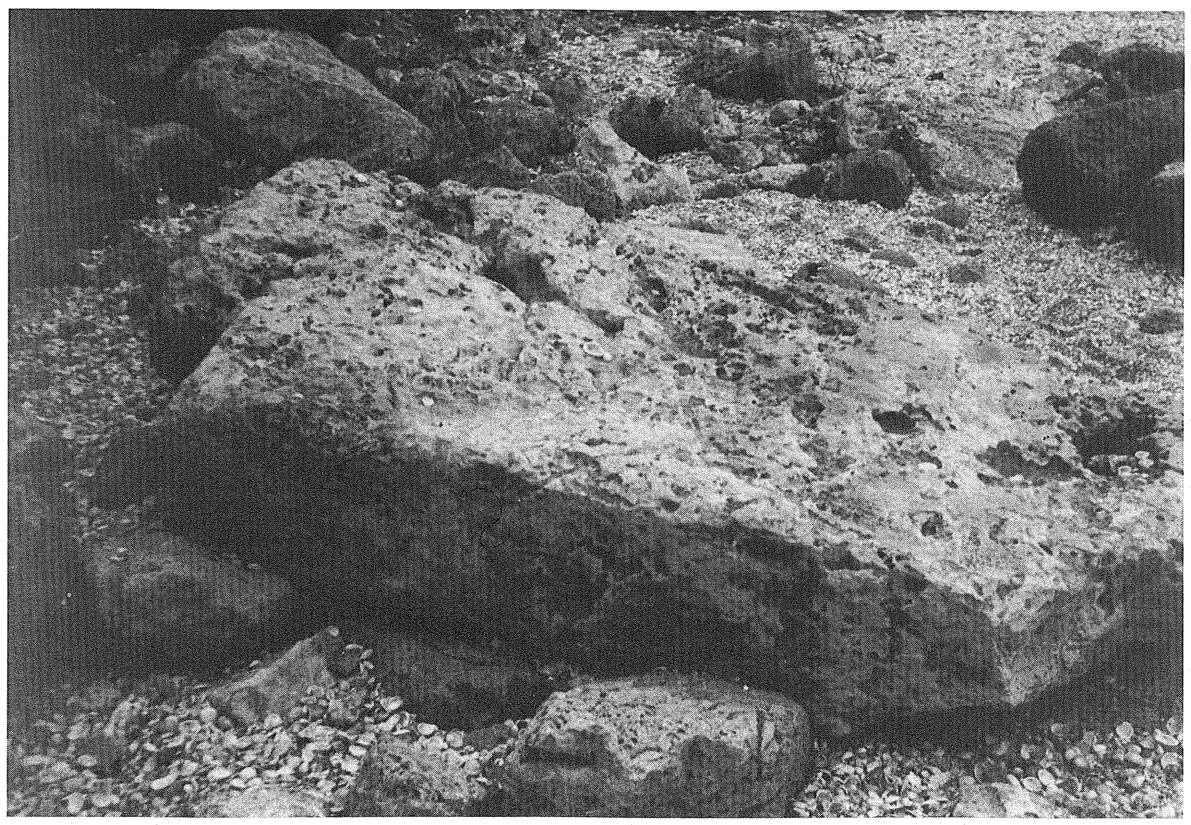

Fig. 17. One of the scarfed paving slabs from the third quay at Dor (displaced and turned upside down).



## 4. Phoenician Harbours

As has been suggested above, the so-called "Achaean" or "Sea People invasion" was not so destructive after all, at least as far as maritime technology and sea-borne activities are concerned. Many coastal cities to the south of Ugarit continued to thrive well after the end of the Bronze Age, and in some cases, such as Byblos, Sidon, Tyre, Akko and Dor, they seemed to receive an additional boost. Though without a proper imperial client to serve, a new type of loose-foot, square rig, merchantman frequented the entire seaboard of the Mediterranean, and even beyond. A score of new trading posts was established on headlands, promontories, and some as yet unchoked river outlets. It seems that the climatic change in the 12th century B.C.E. which had caused eustatic transgression and eventual silting, left only those perennial rivers which were navigable from the sea, mostly in the central and western parts of the Mediterranean, including the Aegean, the Ionian and the Tyrrhanian Seas.

These new havens, and the older ones which were retained, were probably sufficient for the level of trade during the earlier part of the Iron Age. In some cases, unique collaboration between coastal kingdoms and the newly emergent Phoenician maritime civilization might have resulted in more sophisticated year-round, sheltered harbour basins at all known sites of that period – inland, dug-out harbours of the so-called "cothon" type, with either entirely artificial, or dredged, natural courses as navigational channels. Such were the Solomonic harbours at Yaffo and Ezion Geber (at the Gulf of Aqaba, on the Red Sea), the eastern harbour of Kition and, somewhat later, the commercial harbours of Uthica, Carthage and Motya (Raban 1985, 27-30; Nicolaou 1976, 75; Blackman 1982, 92-3).

Fig. 18. Ashlar paved structures of the early 12th century B.C.E. at Enkomi.

From the 9th century B.C.E. the expanding Assyrian empire, with its growing demand for maritime services and sea-borne shipments of timber and metals, encouraged Phoenician sea-trade and necessitated better emporia. The typical new style of harbour is characterized by free-standing, ashlar-built, vertical moles and island-like quays, subdivided into city quays and royal quays (with the revenues and taxation allocated accordingly), but with no protective break-waters or seawalls. Some of these harbours, as at Arwad, Tyre and Sidon were renovations and modifications of existing ones (Frost 1972). Others were built anew, at a new type of site. Such was the mole at the bay of Tabbat el Hamman, next to the coastal site Smyra (the Sumur, see Braidwood 1940, 208-18 and Fig. 19 here), which had no

Fig. 19. The 9th century B.C.E. mole at Tabbat el Hamman during the 1940 excavations (after Braidwood 1942, fig. 2).

protected surroundings, either against the elements or against naval attacks. The best example of such a Phoenician harbour is that at Athlit, which was founded by the Sidonians no later than the 7th century B.C.E. (Linder 1967; Raban 1985, 30-8; and Raban in press).

The site for the new harbour at Athlit was carefully selected on the lee side (the north-eastern side) of a rocky promontory, on an almost inaccessible stretch of a marshy, coastal strip, detached from the hinterland by the Carmel range. On the other hand, the artificial harbour, with its free-standing ashlar header moles, was intended to be relatively open, both to the surge and to all in-sailing ships (see Figs 20, 21).

The main structural units of the harbour are the moles and the quays. The moles were laid on the sea floor, either directly on the evenly levelled rocky bottom, or else on top of



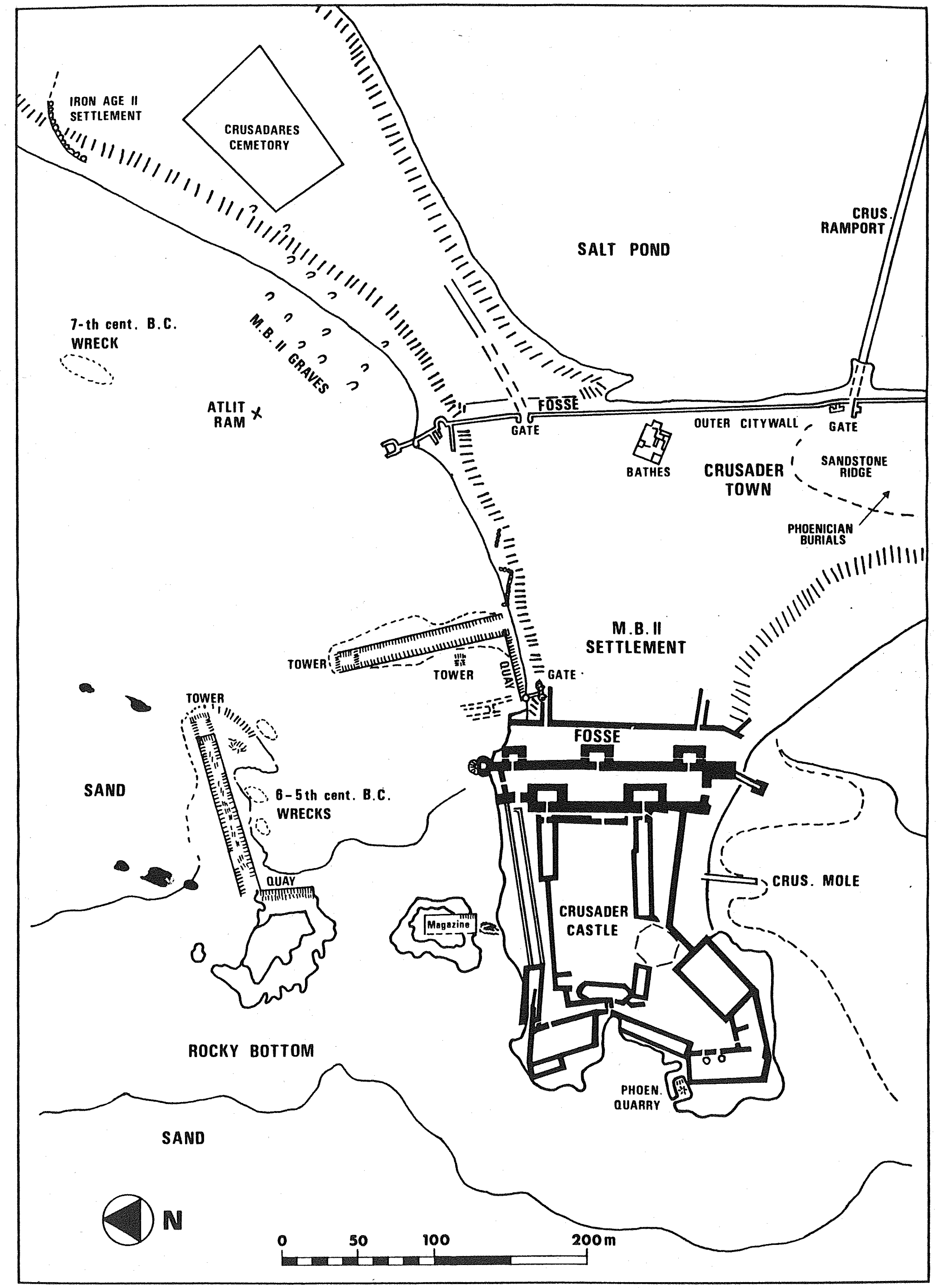


Fig. 20. Plan of the Phoenician harbour at Athlit and its surroundings.

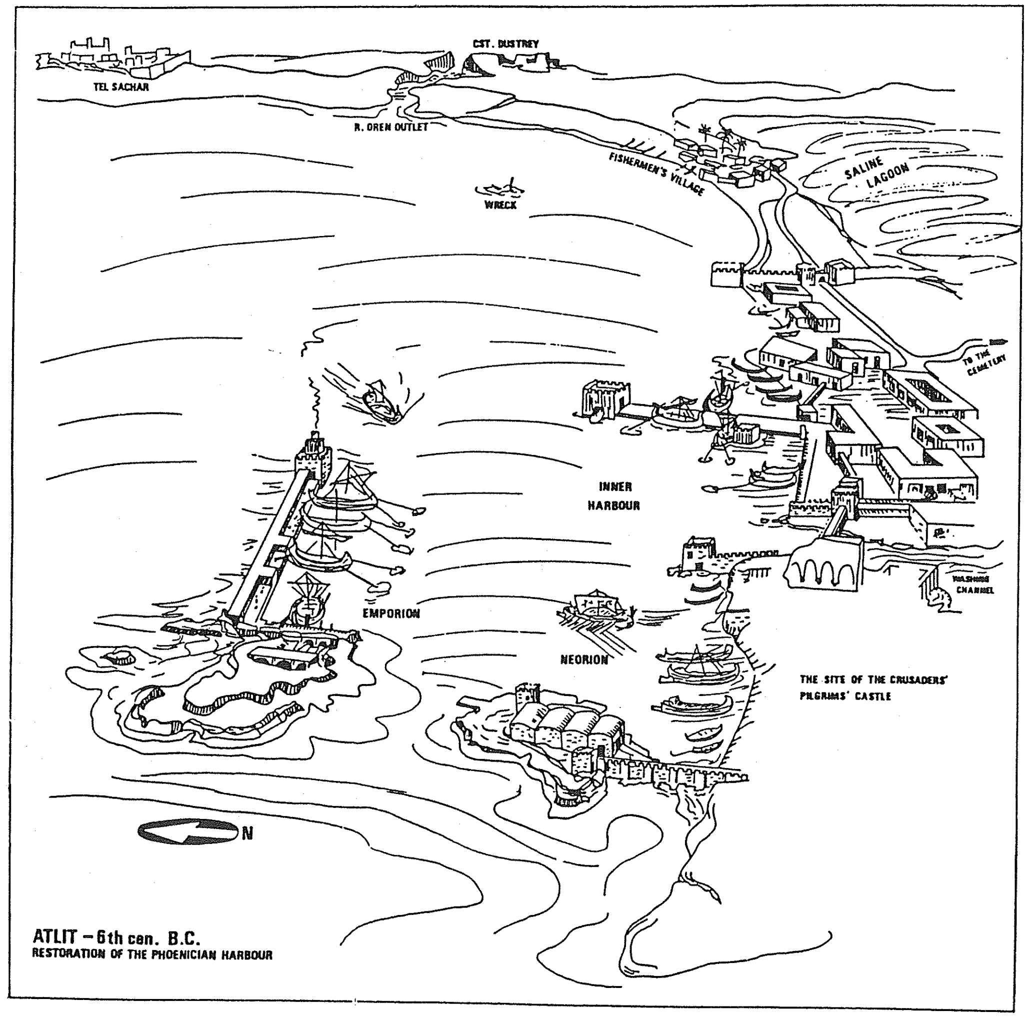


Fig. 21. Artist's rendering of the Phoenician harbour at Athlit.

a wider cushion of rubble and pebbles, which would be heavy enough to endure the undercutting and scouring of wave-perpetuated currents. The moles comprised double walls of carefully laid ashlar headers in tightly fitted courses of dry masonry (Fig. 22). At Athlit these headers are over 2m. long, with an average height of 0.5-0.6m. The total breadth of the moles is about 10m., the length of the eastern one being over 100m., with a 10×10m. square tower at its tip (Fig. 24). These moles were not mere breakwaters, but vertical-sided piers, which would enable merchantmen to berth along both sides. At the stem of each mole, at right angles to it, there is a quay built of the same type of headers – one along the shoreline on the south edge of the harbour basin (Fig. 25) and one adjacent to the lee side of the northern rocky islet (Fig. 26).

The overall plan of the harbour was symmetrical, comprising two detached units of a mole and a quay. The entrance to the harbour was from the east, the better sheltered part of the bay. It was over 80m. wide, and was most probably too wide to be closed by a chain. The 15m. gap between the islets on the weather side was never blocked, so that the surge could keep the harbour basin properly flushed and silt-free.



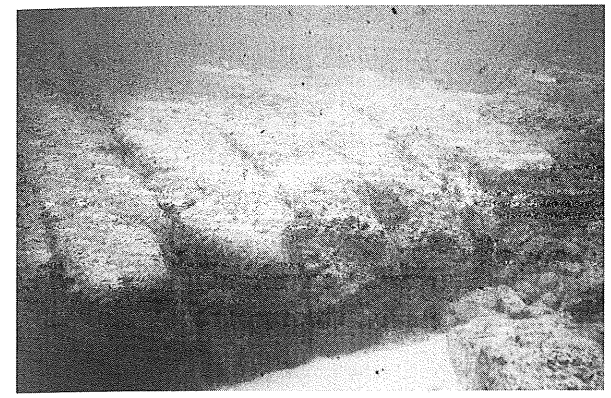

Fig. 22. The western edge of the eastern mole under 1.2m. of water.

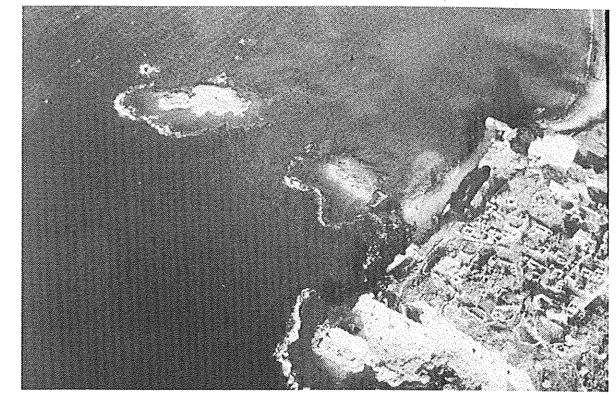

Fig. 23. The promontory of Athlit from the air, looking E-NE, toward the twin rocky islets and the harbour basin behind them.

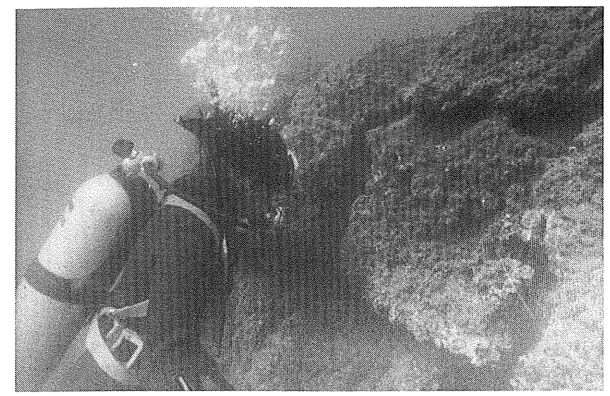

Fig. 24. Diver surveying courses of ashlar headers at the cross-wall of one of the towers along the course of the northern mole.

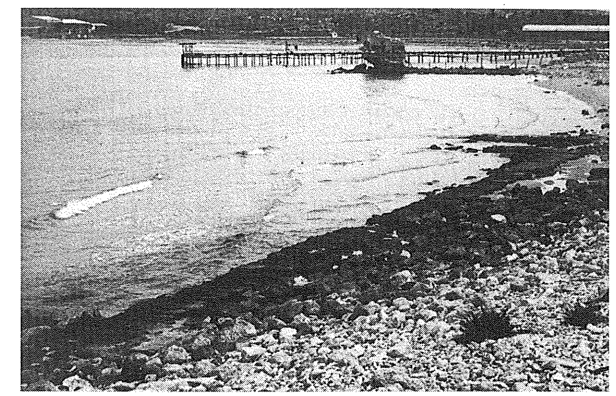

Fig. 25. The southern quay at Athlit and the stem of the double walls of the eastern mole, looking east.

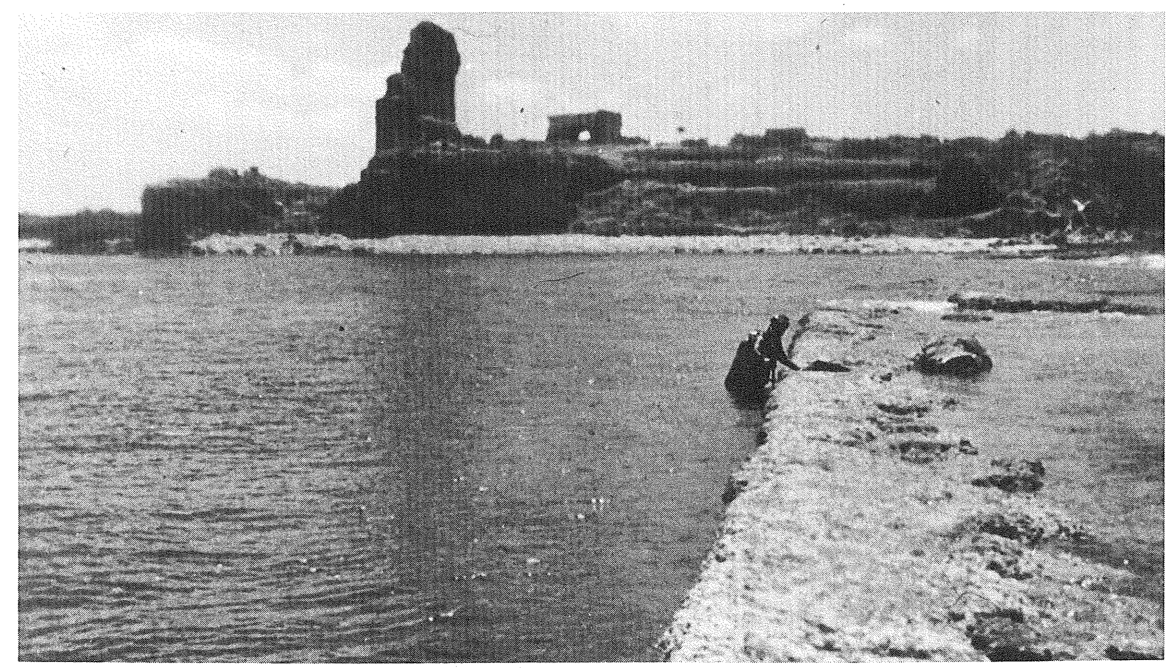

Fig. 26. The NW quay at the lee of the northern islet, looking south.

The planned division between the sector adjacent to the land and the other, detached sector, seems to correspond with both the notion of proper security, against a sudden raid on the storage area by crews of foreign vessels, and with administrative demands to allocate separate berthing piers for the royal quay and that of the city. The first case is illustrated by the ill-fated Egyptian envoy, Wenamon, whose ship was robbed at the harbour of Dor (Pritchard 1955, 26). The second is illustrated by the letter of complaint from as Assyrian official at Arwad, in which he blames the local king for terrorizing merchantmen who attempted to berth at the royal quay, forcing them to berth at "his" city's quay (Hirschberg 1932, 65-72).

The same concepts in harbour planning and building technologies were used at the Tyrian controlled city of Akko. Like many other old, Canaanite sites along the Levantine coast, Akko had passed through many changes in land/sea relations and consequently in the location and characteristics of her harbours (Raban 1985, 35-40; 1986; 1993). These changes, and the growing importance of Akko Bay as a Persian naval base during Cambyses' campaign against Egypt, brought about the construction of a Phoenician-style, artificial harbour at the southeastern side of a headland (Fig. 27). This new location, which was exposed to the full might of the southwestern winter storms, demanded a full-scale breakwater, to create a properly protected haven. Yet the Phoenicians prefered to establish a mole, 12m. wide and almost 300m. long, with ashlar-built courses of tightly matching headers, almost identical to those at Athlit. This mole stemmed from the western end of the southeast corner of the rocky peninsula, and incorporated several 2-3m. wide gaps along its western portion, which enabled water to circulate freely within the basin. Otherwise, it would have become the terminal for the sand which was regularly carried by the current along the shore of Haifa Bay. More recently, the modern fishing harbour built in 1965 and the new marina (Fig. 28) are dredged, every few years, to maintain sufficient water depth in the haven.

Like all other Phoenician harbours, further north along the Levantine coast, Akko's harbour was renovated time and again during the course of the 2000 years during which it was the main maritime gate to Palestine. However, years of underwater research have enabled us to determine its original form, which dates to the mid 6th century B.C.E., with some minor changes during the Classical and Hellenistic periods. Besides the main mole, the other component of the Phoenician harbour was a free-standing, fully artificial island, or rectangular quay, 13×60m. in size, with its southwest edge lying in 6m. of water (Fig. 29). The artificial emporium quay was built using carefully laid ashlars. Our study has identified two distinct phases in its construction, the second one dating to the 3rd century B.C.E. (Fig. 30). It seems as if this artificial island, known as the "Tower of Flies" since the Middle Ages, served the same function as the northern sector of the harbour of Athlit. Although laid very carefully on the sea bed, or over lower courses, there is no evidence for how the ashlars (each weighing more than one ton) were hoisted and laid down, no doubt by some mechanical devices, such as were found on the similar mole at Amathus, in Cyprus (Fig. 31).

Published data from the excavations and geomorphological surveys carried out by the French School at the harbour of Amathus are very tentative (Aupert 1979; Empereur and Verlinden 1987), as is the original layout of this Late Classical (?) or Early Hellenistic maritime complex, and the answer to the question whether it was ever completed. Perhaps the uneven manner in which the courses of ashlar blocks were laid and the untrimmed tenons



Fig. 27. General plan of the ancient harbour of Akko.


Fig. 28. Aerial photograph of the harbour of Akko in 1968, from the southwest.

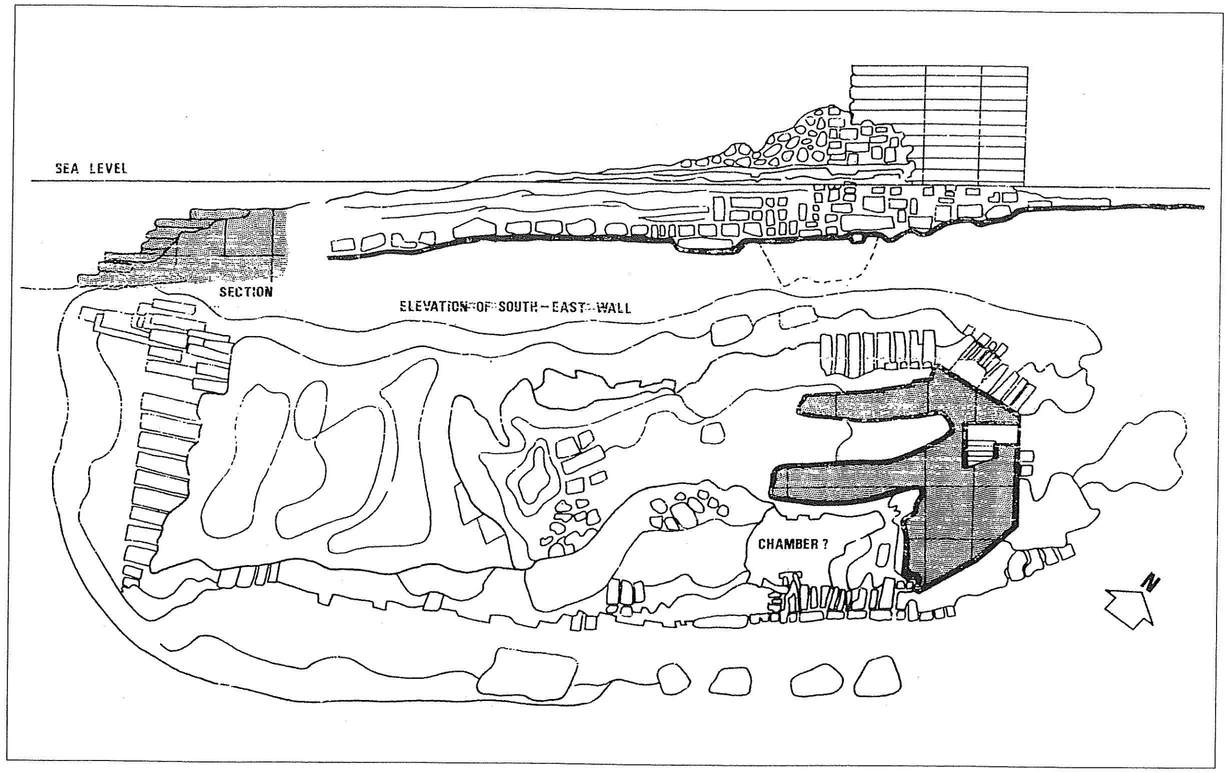


Fig. 29 (a)

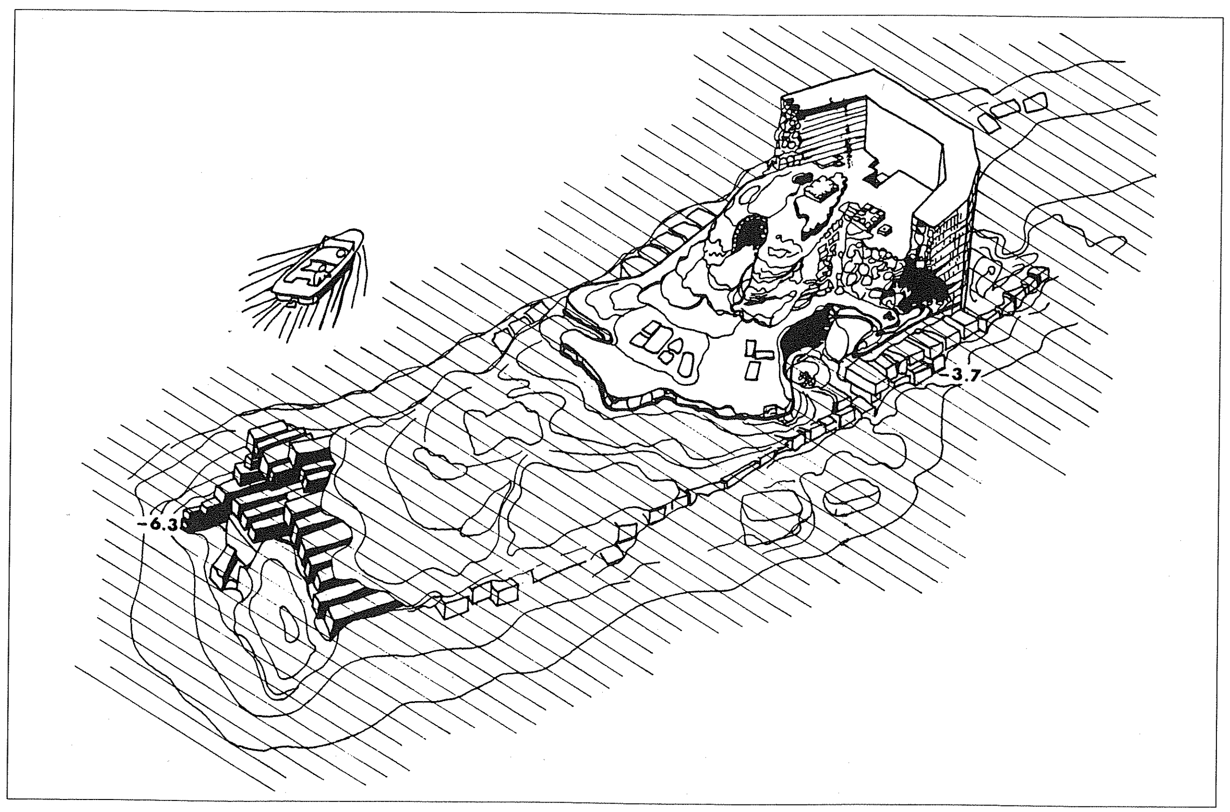


Fig. 29 (b). Plan and three-quarter view of the "Tower of Flies".



at their ends, which differ in style from Phoenician harbour works in the Levant, indicate that they were laid in haste and the work was never properly finished (Empereur and Verlinden 1987: 8, 15). If the ashlar quay of the moles was backed by a rampart of large, uncut blocks, which faced the open sea, then we have here a true breakwater of a type previously unknown in Phoenician harbours: this is indicated, for example, by the lead clamps, (*ibid.*, 11), which are typical of Classical Greek architecture, and the very concept of a closed, unflushed basin. One wonders whether the harbour of Amathus was intended to serve as a naval base, for large-scale, sea-borne trade. Due to the tectonically unstable site of the harbour it is even more complicated to determine what the depth of water in its basin was when it was built where the coastline was and what the relationship was between the presently inundated basin and both the alleged inner basin and the urban settlement.

All in all, the present state of knowledge would identify the harbour at Amathus as a transitional type in the introduction of the Hellenistic *Limen Kleistos* to the Near East. The hoisting devices and grooves for lead clamps, also traced in the lower courses, are also known from the artificial islet type of offshore quay at Zire, the long, natural island of Sidon (Frost 1973, 83-6). The berthing unit would be well away from the city harbour itself, safe enough for loading, unloading and serving berthed merchantmen during the sailing season (Fig. 32).

As for the other city harbour of Sidon, one can say little about the fine division between its Classical-Phoenician phase, the Hellenistic phase and the later Roman components. Poidebard and Lauffray (1951) directed a series of underwater surveys, aerial photographic documentation and some test probes during the construction of the modern fishing harbour of Sidon in the late 1930's and early 1940's. They found that the original harbour was built adjacent to and along the lee side of the north-pointing rocky promontory which diverged from the curved shoreline towards the northeast. The rock itself was levelled close to the water level, except for its western, external side, which was left intact as a natural seawall. Later, during the Roman period, additional courses of huge rectangular blocks were added to the wall, as at Akko, Tyre and Arwad. A mole was laid running northeast for over 230m. from its stem at the tip of the promontory, on its lee side (Fig. 33). This mole was 7.5m. wide and comprised two parallel walls of ashlar headers: the external wall over 2m. long, 1m. wide, and at its highest just short of that; the internal headers, facing towards the harbour basin, about 1m. long, 0.4-0.5m. wide and 0.3-0.45m. high. At the tip of the mole, towards the open sea, there was an ashlar-built rampart, 27×15m., on the side of the mole's external wall.

It seems that this unit was built during the Hellenistic era, probably replacing the twin artificial platforms on the lee side of the island, over an earlier "Bastion", or a quay built of headers, measuring 1.8×0.5×0.5m. each. While dredging the harbour in 1946, another mole was found at the eastern side of the entrance channel. Most of it was destroyed during the dredging, but it seem to have had a total width of 15m. and was built from ashlars of similar size to those of the external wall (see above). There is no doubt that this harbour basin could have been closed by a chain across its channel, and that it was protected by a high wall which ran along the crest of the rocky promontory. Thus it might be described as a "Closed Harbour" or *Limen Kleistos*. The important feature is its series of flushing channels, which were cut across the breadth of the promontory (Fig. 34). The aerial photographs taken before the modern harbour was built clearly demonstrate the efficiency of

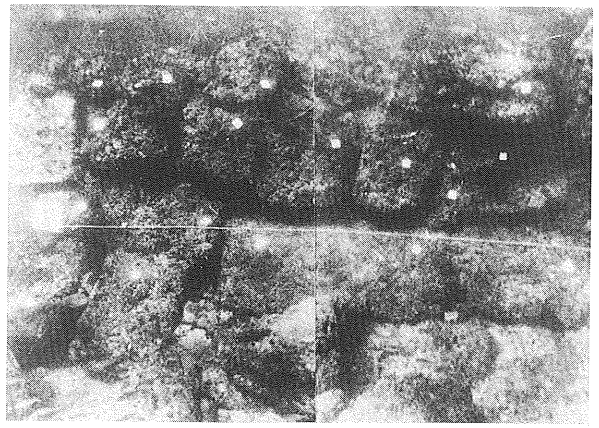

Fig. 30. Ashlar courses *in situ* under the water along the eastern face of the "Tower of Flies".

Fig. 31. The ashlar headers mole at Amathus, before the French excavations (1971).

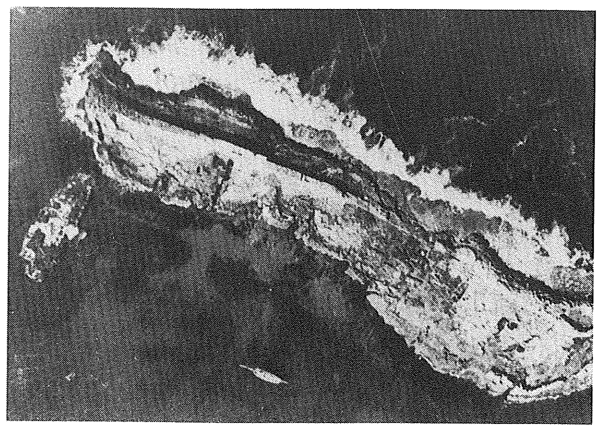

Fig. 32. Aerial photograph of Sidon island with the rectangular quay, or platform on the left-hand side.

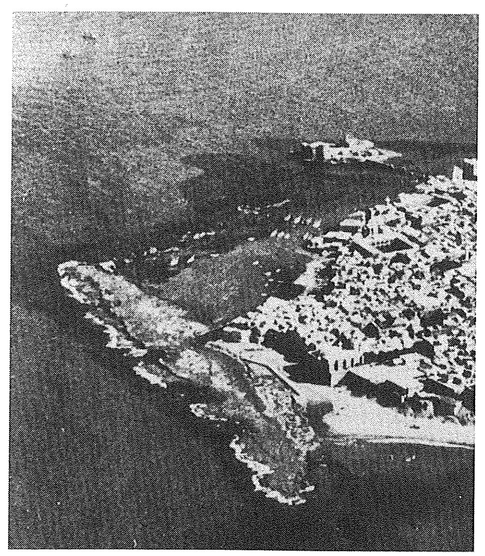

Fig. 33. Aerial view of Sidon's harbour from the south, in 1940.

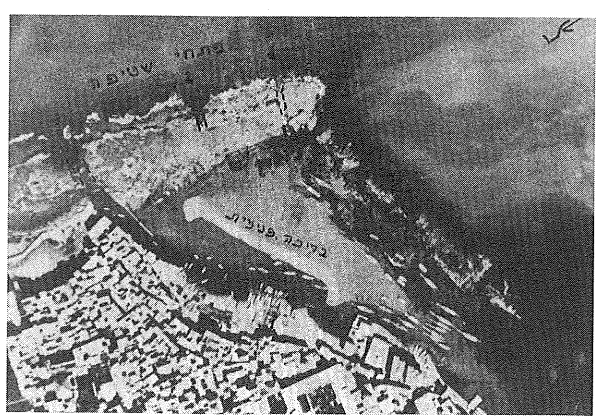

Fig. 34. Aerial photograph of the harbour of Sidon in 1942.

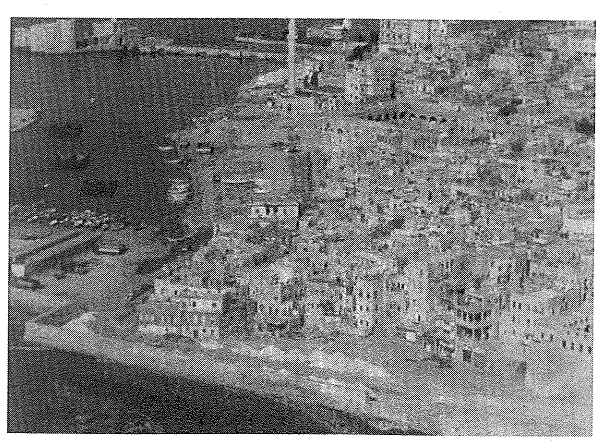

Fig. 35. Aerial photograph of the inner part of the harbour of Sidon in 1982, looking toward the north.



the southern channel, the only one which was not blocked in later antiquity. Remains of that vital channel are still visible in the aerial photograph taken in 1982 (Fig. 35). One can see, however, that the blocking cement wall has caused the subsequent, additional silt-up of the harbour basin, which at present can accommodate only shallow drafted fishing boats and steel barges.

## 5. The Hellenistic *Limen Kleistos*

With the rapid growth of naval power and the decisive role of military fleets, triremes and polyremes, well protected naval bases became an essential component of harbours in every city with political and economic aspirations for autonomy during the Hellenistic period (Blackman 1982, 189). This process had gained momentum during the Classical period, following the Persian Wars against Greece and the long period of naval conflicts during and after the Peloponnesian Wars, and during the Athenian attempt to establish her naval empire. During this period a new type of harbour was favoured —the multi-basin *Limen Kleistos.* This type of harbour had two or three separate basins, all located within the city walls. Often, wherever possible (and especially in places where the city and her harbour were built anew) the city walls continued over the harbour moles, hence the harbour channel became a closed "Sea Gate" (*ibid.*, 193-6).

On Cyprus, Salamis may have had such a harbour during the Classical period, perhaps built by King Evagoras I. The main, older part of the harbour, in the bay on the south side of the city, served as the emporium. This comprised a long, narrow basin along the eastern seafront of the city, in the lee of the presently submerged long-shore reef —an area used for the maintenance of local boats, dock yards and storage facilities (the Neorion?)— and an alleged separate dug-out basin, in the later silted-up lagoon on the north side, a "secret" harbour for the naval fleet (Karageorghis 1969, 167; Flemming 1974. Here, fig. 36). The line of the city walls, which date to the Classical period, encircles all three basins and probably also continues along the presently submerged reef, up to the promontory in the northeastern side of the southern bay. The only possible candidate for a basin which might fit Pseudo-Skylax's claim for the existence of a wintering harbour at Salamis, is the alleged military harbour in the north. The suggested rate of submergence of *ca.* 2m. since the Classical era (Flemming 1974, 170-2) might be the reason for excessive silting in the northern basin (due to the lack of a proper gradient for the stream-carried silt) and the partial silting of the southern harbour, within the estuary of the Pedieos river (Collombier 1987, 168-72). The seawall along the northeastern side of the southern harbour seems to have been external to the city wall, according to security and administrative

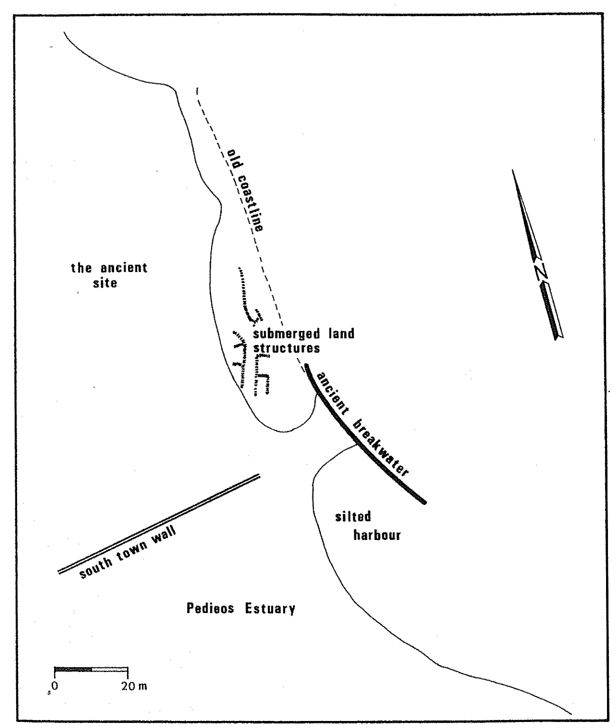


Fig. 36. Sketch plan of Salamis, based on Linder & Raban's 1971 survey.

Fig. 37. Ashlar walls of the ancient mole at Marion-Polis, looking to the north.

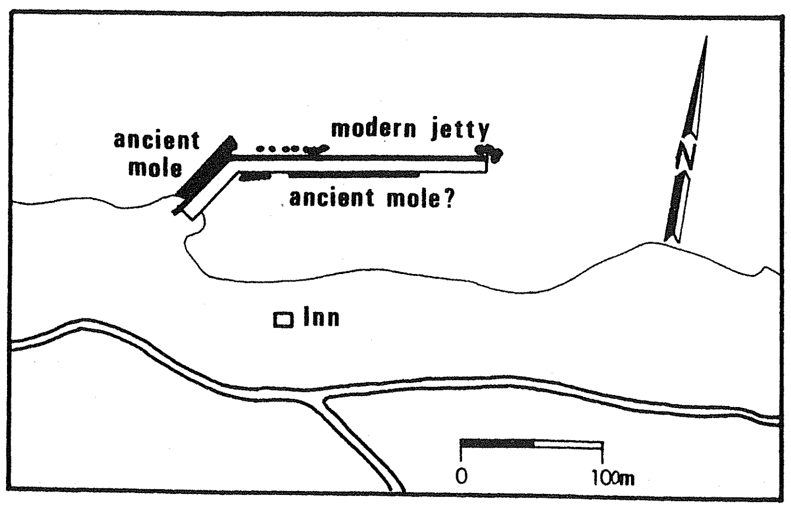


Fig. 38. Sketch plan of the harbour of Marion-Polis (Lachi), based on Linder & Raban's 1971 survey.

needs (Blackman 1982, 194). The seawall of the south harbour was built of properly laid courses of ashlar headers, 1.0×1.0×1.8m., on top of a loosely spilled rampart of larger blocks, down to the present depth of over 6m. This technique of spilled rampart, or breakwater, was not used in Phoenician harbours, but was quite common in Greek harbours, such as the 6th century B.C.E. harbour at Samos, the Classical harbour on Aegina and the commercial harbour at Cnidus.

The harbours of Salamis may represent an era when the focus of maritime activities in Cyprus was aimed more towards the Greek harbours of southern Anatolia and the Aegean, and towards the piratical activities along the Cilician coast (focusing on the Phoenico-Persian maritime routes), but less so towards Egypt. Also illustrating this phenomenon are the alleged harbour of



Karpasia and others mentioned by Pseudo-Skylax, mostly along the nothern coast of the island: Kyreneia, Lapithos, Soloi and Marion. Soloi is also mentioned, along with Salamis, as a closed, well protected, wintering harbour. Modern loading facilities for copper ores and additional structures of the late antiquity make the survey of the original harbour almost impossible. Yet its location, at the eastern side of the delta of Potamos tou Kampou is well attested. Two moles, 180m. apart, running from the shore to the open sea, with scattered ashlar blocks, measuring 0.6×0.6×2.0m., may belong to what has survived of the outer harbour. Strabo's anchorage and the closed basin mentioned by Pseudo-Skylax may be found in the presently landlocked area to the south (Karageorghis 1968, 102).

Further west along the north coast was the small harbour of Marion, just east of the outlet of the Khrysokhou river. Marion was a major export centre, handling copper ore (and probably also gold and timber), and serving the Tamassos mines. The economic importance of Marion caused constant rivalries between the Phoenicians, the Greek colonists, the Persians and the Ptolemies (Hill 1972, 99, 119, 156, 159-60). The remains of the ancient harbour, abandoned in the early Hellenistic era, are presently overbuilt by the mole of the modern fishing harbour. Yet, one can still see the ancient northwestern mole of ashlar headers, laid in good order and fastened by iron and lead clamps of typical, Hellenistic, "Dove-tail" type (Fig. 37). The average size of these blocks is 0.8×0.8×2.0m., the length of the visible mole being over 40m. The main mole, under the present one, though it is now well below the waves, was at least 1.5m. higher relative to the sea level when in use. On the outside, behind the modern mole, there are tumbled ashlars from the ancient seawall. Inside, under 0.6m. of water, there is a quay over 2m. wide, which has survived in sections of 30m. and 58m. (Fig. 38). The size of the ashlars cannot be measured, due to a coating of plaster over the surface of the quay (perhaps a layer of marine encrustation).

On the central, northern coast of Cyprus there were two neighbouring harbours, described by Pseudo-Skylax as anchorages and by Strabo as "hormos" or "proshormos" (see also Leonard, this volume). The western one is Lapithos (or Lapethos, or Lampousa-Lambousa) —a Phoenician city until the Hellenistic era, and the capital of one of the four Cypriot districts during the Roman era (Hill 1972, 12). The city was the centre of a flourishing agricultural and fishing area and its harbour was of greater importance than that of Kyrenia.

The harbour of Lapithos may have been well preserved, but it was covered with modern cement moles in the early 1960's. The moles were surveyed and measured in the late 1950's (Nicolaou 1976, 135; here Fig. 39). The main mole runs west-southwest for over 155m. and was just over 10m. wide. It seems as if it was laid over a western continuation of the coastal ridge (as is suggested by the nautical maps of the British Admiralty). The western tip of the main mole overlaps the tip of the southwestern one, which is only 40m. long, and had an inner quay (now covered by cement) of ashlar headers on its inner, eastern side, an additional width of 3.6m. Our own underwater survey suggests that the main mole comprised two building phases, along the same master plan. The earlier phase was the better built, and comprised vertical ashlar walls built in the Phoenician style. Yet what is visible is mainly a spill of square blocks, 1.5×1.5×1.5m., belonging to the second (Roman) phase. There was probably a second harbour basin next to the eastern city wall, north of *Trouli* Hill, in what is now low, marshy ground. In the sea north of that location we have traced several concentrations of broken amphoras of the Cypro-Phoenician "basket-handle" type.

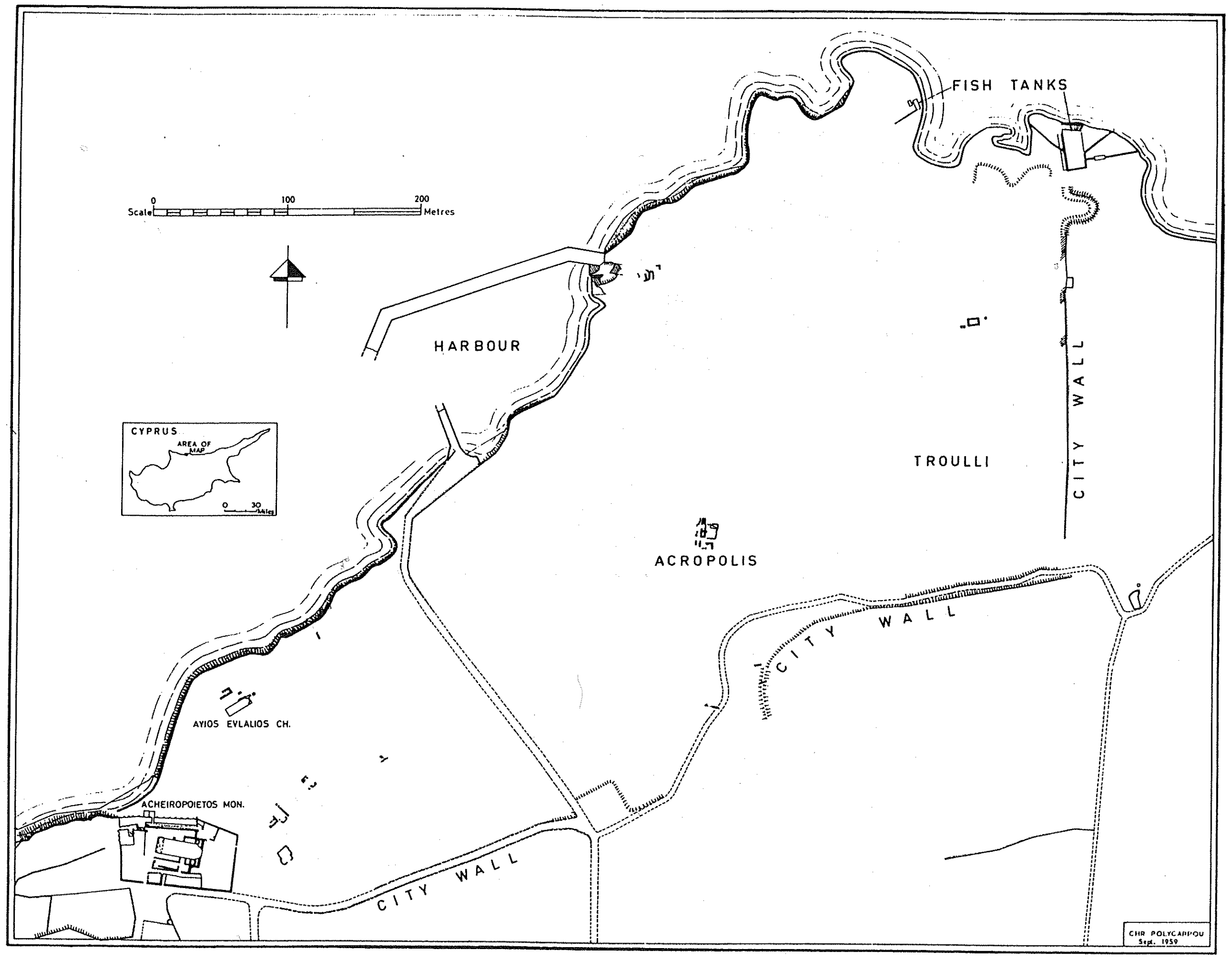


Fig. 39. Plan of Lapithos and its harbour (after Nicolaou 1976, fig. 1).

The ancient harbour of Kyrenia (like the one at Famagusta) is very hard to detect, due to its long and varied periods of use. Presently it opens to the east, and the modern break-water, which runs over the sea side of the Venetian castle, might cover some ancient remains. However, until the 1950's its entrance was to the north and was badly protected from the northern surge. Only along the external side of the modern, western mole, are the ancient ashlar courses still visible above and below the water level (Fig. 40). The higher courses of blocks —maybe of Roman or even Medieval date— , 0.6×1.0×2.3m., serve as a base for the modern mole. Further to the west there is a flat platform, 12-15m. wide, of ashlar slabs under 3m. of water. This platform was laid on top of levelled bedrock and terminates in the west in a vertical quay, built of ashlar headers, measuring 0.6×0.5×2.0m. The lowest surveyed course is over 6m. below the sea level and 2m. above the sandy seafloor. The platform is littered with sherds of Hellenistic or Classical date (Fig. 41). These structures continue northeast from the present shore for *ca.* 40m., a few metres beyond the lighthouse. There the line turns southeast for *ca.* 19m., and again-towards the northeast and the open sea, along a traceable line of almost 20m., at a depth of 6m., over the sand bottom. There too, most of the sherds are of Hellenistic date.



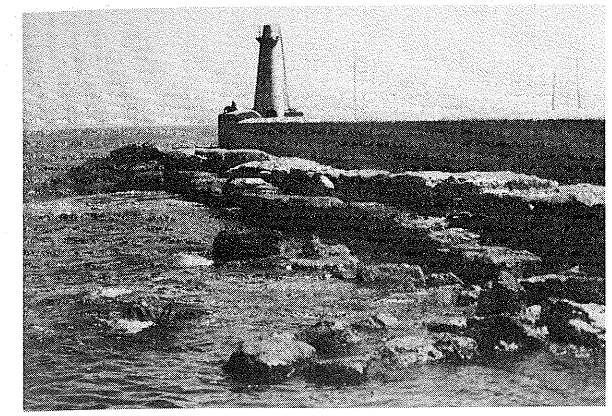

Fig. 40. The ancient ashlars on the western side of the harbour at Kyrenia, of the Roman or Medieval period (?) looking to the NE.

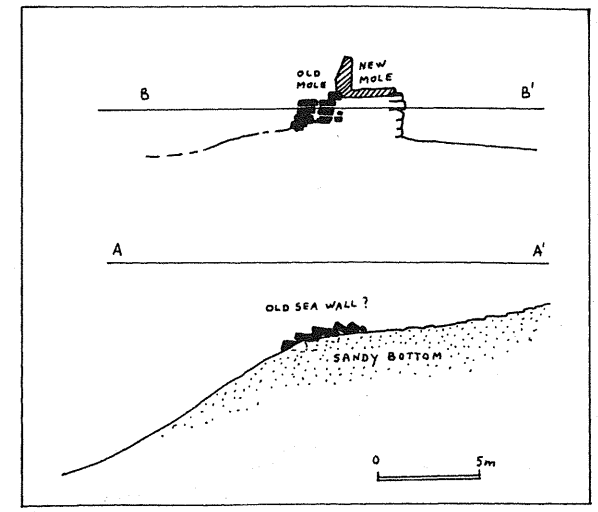


Fig. 41b.

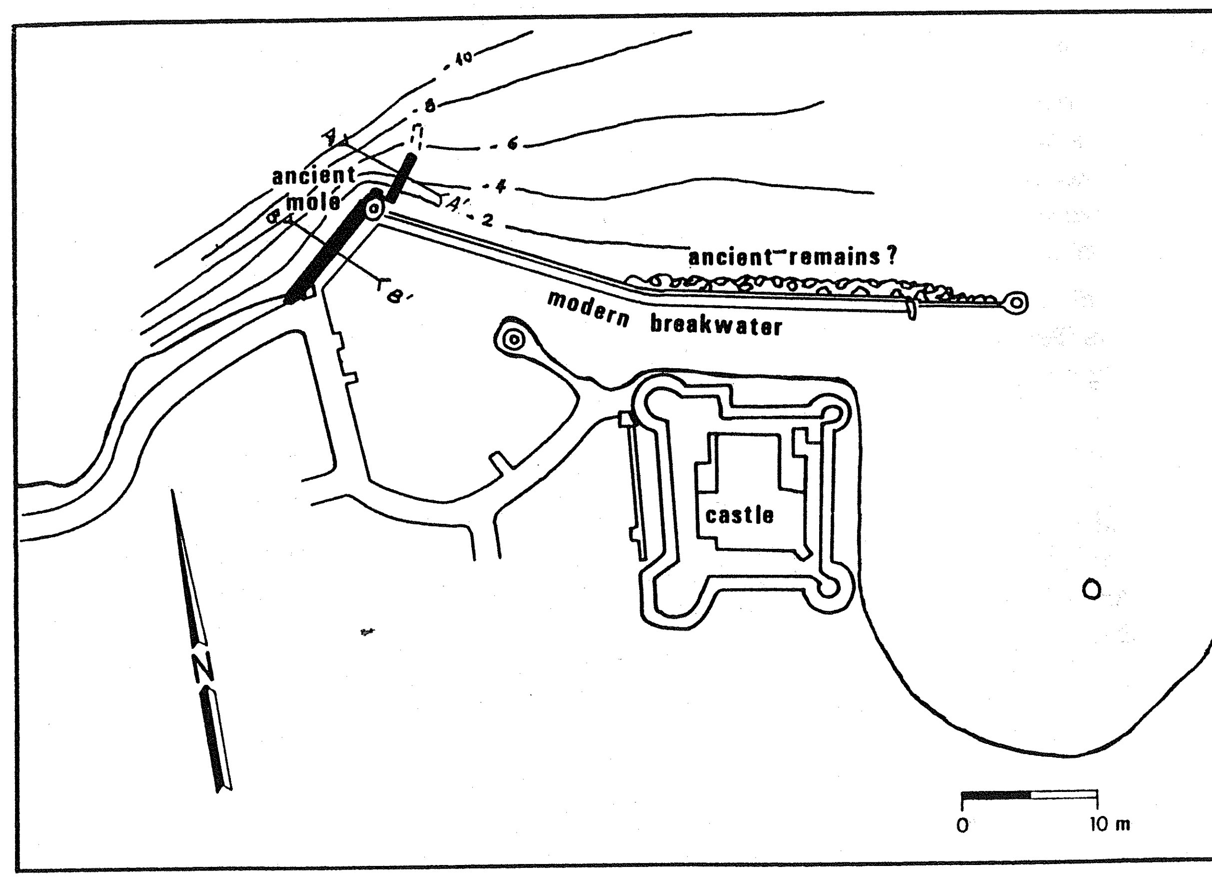


Fig. 41a,b. Sketch plan (a) and sections (b) of the harbour of Kyrenia, based on Linder & Raban's 1971 survey.

The best example of a *Limen Kleistos* on Cyprus is probably at Nea Paphos (Mlynarczyk 1991). As this harbour is presently under extensive survey and trial excavations (see Hohlfelder, this volume) there is no need to discuss it in this paper, other than to include a plan made during our 1971 survey, prior to the construction works at the tip of the southern mole and the promenade along the western shoreline (Fig. 42). There we man-

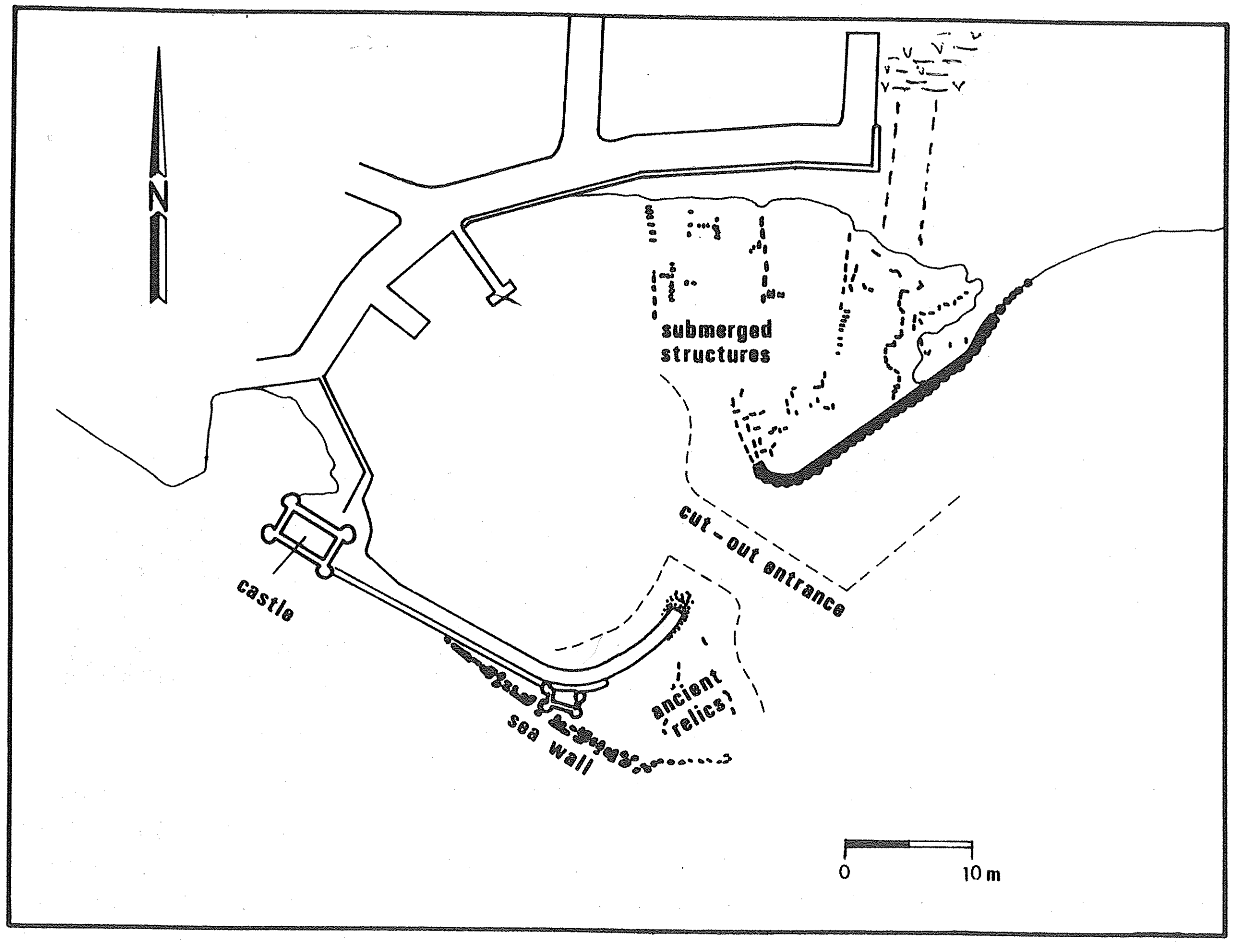


Fig. 42. Sketch plan of the harbour of New-Paphos, based on Linder & Raban's 1971 survey.

aged to trace the remains of what appeared to be an ashlar-delineated navigational channel, 4-5m. wide, leading north toward what was then a marshy low-ground – a good candidate for a dug-out, inner harbour.

In the Levant most harbours of the Hellenistic era were built on earlier harbours, some of which were modified and reconstructed to fit the concept of *Limen Kleistos* (see above, Akko, Tyre and Sidon; Frost 1972). The new ones, at Laodicea and Antiochia, have not been studied properly, and their exact features and building technology are still unknown. One good example though, is the Phoenico-Hellenistic harbour of Straton's Tower, built at the site later selected by Herod the Great for his royal harbour of Sebastos (Caesarea). We do not know exactly when and by whom the harbour town of Straton's Tower was established, but we do know that it was already a Ptolemaic naval station in 258 B.E.C. By the end of the 2nd century B.C.E. it was the stronghold of a local tyrant by the name of Zoilus, who managed to withstand the naval siege of the Seleucid king, Demetrius, and the Jewish king, Janneus (Raban 1987b; 1992). By that time the city was protected by a wall on all sides and had two separate harbours. The harbour to the north was sheltered by a series of reefs, protecting the western continuation of the northern city wall, and a 30m. long ashlar quay of long, slim headers (Fig. 43). To the southwest the city encircled a rocky hillock and continued westward, across the water's narrows, towards an inshore, rocky islet



Fig. 43. The quay of the northern harbour of Straton's Tower, looking toward the west.

(presently known as the Harbour Citadel). So, the encompassed little bay to the northeast was a well protected basin. The eastern side of this rocky-bottomed basin was quarried so that it would be deep enough to berth ships of considerable size. The seawall that continued the defense line along the waterfront ends some 30m. short of the southern city wall. This is topped by a round tower (presently inundated), which marks the northern flank of the entrance channel into the harbour (Fig. 44).

## 6. Sebastos, the Royal Harbour of Caesarea Maritima

The best example of harbour technology from the Roman era in the Levant is represented by the harbour built by the Jewish king, Herod the Great, over the already unused anchorages of Straton's Tower. The harbour is not only the largest and most sophisticated complex of hydraulic engineering in the history of the ancient, eastern Mediterranean, it is also the best documented in historical record, and the most extensively studied by archaeologists. Thus it will be presented here in some detail, as it is of some relevance for modern, coastal engineers and harbour planners.

Josephus Flavius' books are our only ancient literary source for the construction of Caesarea and Sebastos. He was active some three generations after their inauguration by Herod, yet Josephus spent some time in Caesarea, long enough to make careful observations around the city and its harbour, which was still fully operational and much as Herod had built it. If there were a few later additions, it seems that Josephus did not include them in his narrative, which is always in the past tense when describing Sebastos, its components and construction. So he wrote:

*and the greatest work (in Caesarea) which has caused the greatest labour, was the estab-*

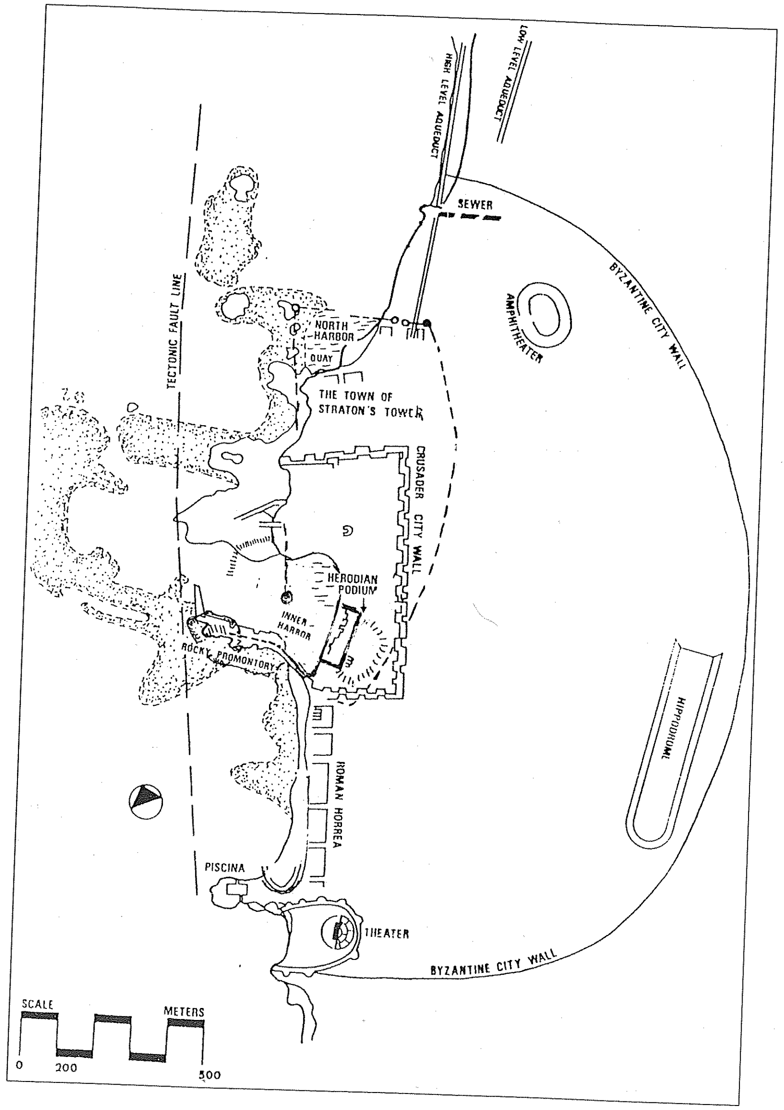


Fig. 44. A sketch plan of the town of Straton's Tower and her two harbours.

*lishing of a protected artificial harbour of still water, as large as the one in Piraeus, and which included quays, additional basins and extra mooring berth; but what was especially notable about this construction was that he got no material suitable for so great a work from the place itself, but completed it with materials brought from outside (the country) at great expense. Now this city is situated in Phoenicia, on the route to Egypt, halfway between Dor and Joppa. These are lesser cities, with poor mooring places, since they lie open to the southwest wind, which constantly sweeps up the sand from the sea floor onto the shore and thus does not permit a smooth landing. Most of the merchantmen must ride unsteadily at anchor offshore.*

*To correct this topographic drawback he (Herod) laid out a circular harbour on a scale large enough for a large fleet to be moored by the shore, and let down enormous blocks of stone to a depth of 20 fathoms. Most were 50 feet long, not less than 18 feet wide, and 9 feet high (15.3×5.5×2.7m.). The structure which he threw up as a barrier against the sea was 200 feet wide. Half of this opposed the breaking waves, warding off the surge breaking there on all sides. Consequently it was called Prokumatia (breakwater).*

*The rest comprised a stone wall, set at intervals with towers, the tallest of which, quite a beautiful thing, was called Drusion—taking its name from Drusus, the stepson of Caesar, who died young. A series of vaulted chambers was built into it for the reception of those who came from the sea, and in front of the vaults— a wide curving quay encircled the whole harbour, very pleasant for those who wished to stroll around. The entrance, or mouth was built towards the north, for this wind brings the clearest skies.*

*At the foundation of the whole encircling wall, on the port side of those sailing into the harbour, was a tower, built up on a broad base to withstand the water firmly, while on the starboard side were two great stone blocks, taller than the tower on the opposite side upright and yoked together.*



*A continuous line of buildings, finished with highly polished stones, formed a circle around the harbour, and in their midst was a low hill, carrying a temple of Caesar visible from afar to those sailing towards the harbour (JA, XV, 331-9).*

In his other work, *The Jewish War against Rome*, Josephus wrote as follows:

*Having calculated the relative size of the harbour he let down stone blocks into the sea to a depth of 20 fathoms. Most of them were 50 feet long, 9 feet high, and 10 feet wide (15.3×2.7×3.1m.) and some even larger. When the submerged foundation was finished, he then laid out the mole above the sea level 200 feet across. Of this a 100 foot portion was built out to break the force of the waves, and was consequently called the Prokumia (breakwater). The rest supported the stone wall that encircled the harbour. At intervals along it were great towers, the tallest and most magnificent of which was named Drusion, after the stepson of Caesar. There were numerous vaulted chambers for the reception of those entering the harbour, and the whole curving structure in front of them was a wide promenade for those who disembarked. The entrance channel faced north, for in this region, the north wind always brings the clearest skies.*

*At the harbour entrance there were colossal statues, three on either side, set up on columns. A massively built tower supported the columns on the port side of ships entering the harbour; those on the starboard side were supported by two upright blocks of stone —yoked together, higher than the tower on the other side. There were buildings right next to the harbour also built of white marble, and the passageways of the city ran straight towards it laid out at equal intervals. On a hill directly opposite the harbour entrance channel stood the temple of Caesar, set apart by its scale and beauty. In it there was a colossal statue of Augustus, not inferior to that of Zeus at Olympia, on which it was modelled, and one of the Goddess Roma, just like that of Hera at Argos. He dedicated the city to the province, the harbour to the men who sailed in these waters, and the honour of the foundation to Caesar (JW, I, 408-15).*

The harbour in Josephus' description was called *Sebastos*, the Greek form of the Latin title *Augustus*, which was given to Caesar by the Roman Senate. The two differing names —Caesarea, for the city and Sebastos, for the harbour— had a very distinct administrative difference. While Caesarea was a provincial *polis*, with her semi-autonomous, municipal institutions, such as at Akko, Ashkelon, and the cities of the Decapolis, Sebastos was a royal or state entity, with its revenues going straight to the royal court in Jerusalem. The fact that Herod added a new polis within the boundaries of Judea, or his Jewish kingdom, was considered a deed of sacrilege and was probably the reason the Talmud called her "A post stake within Israel" (Megilla 6a). Sebastos, as a separate entity, was mentioned on several occasions by Josephus (*JA*, XVII, 87; *JW*, I, 610-13), as well as in the epithet of Caesarea, on the coins which were issued up to the time of Nero (68 A.D.): "Caesarea, which is by the Sebastos harbour" (Ringel 1975, 83).

After the quelling of the Great Jewish Revolt and the destruction of the state of Judea, the harbour was given by Titus to the people of Caesarea. Then the city's epithet was established as "Colonia Prima Flavia Augusta Caesarea", as is found on her coins of the period and inscribed over a large, marble architrave, found at the site of her temple platform (*ibid.*, 85).

It seems that this administrative division had been a basic concept in the master plan of Herod's architects, when they renovated the existing walls of Straton's Tower, as a dividing line between the city and the royal territory of Sebastos (within these walls). One might argue that the fact that these walls retained their role as a landmark for the boundaries of the Holy Land as late as the 7th century A.D., in Jewish tracts, is reminiscent of that function (Raban 1987b; 1992).

As long as it was a royal entity, serving the commercial enterprises of the entire kingdom and maintained by the state, Sebastos could function properly. Yet, it seems as if it were too large and costly to be maintained by the municipal administration of a single city, such as Caesarea. For this reason, and because the great moles were laid over tectonically unstable seafloor, the harbour had already begun to deteriorate and subside by the first century of our era (Raban 1992b). This destructive process was vividly described by Procopius, the Bishop of Gaza, some four centuries later, in a eulogy to the Byzantine Emperor Anastasius I (481-518 A.D.):

> *Since the port of the city named after Caesar had fallen into bad condition in the course of time and was open to every threat of the sea, and no longer, in fact, deserved to be called as an harbour, but retained from its former fortune merely its name, you did not overlook her needs and her constant laments over ships which frequently, escaping the perils of the high seas, were wrecked in the harbour. Those who waited the cargoes suffered pitifully, seeing the destruction of those things of which they were in need, watching it without being able to help...* (Levine 1975, 18).

Our recent studies have shown that such pitiful descriptions were already a reality towards the end of the 2nd century A.D. Remnants of wrecked cargo over the partially submerged mole and datable deposits of high energy waves in the lee of the Herodian breakwaters and the back shore (stratified between artificial floors) are good indications for the early start of the this destructive process (Raban 1992b).

Our archaeological research of the sea floor has revealed much which Josephus did not see. The great moles portrayed above gradually subsided, and what was originally at the water level is today more than 5m. below the waves. Most of the upper structures, such as the wall, the towers and the vaults collapsed, and their debris were already scattered by the surge in antiquity. Yet, the part of the mole that was originally below the waves, the substructure on which these features had been established, remained almost intact, due to the protected environment below the tumbling mass of the superstructures, deep under the devastating surge. Thus we can fill in and add to the verbal depiction of Josephus, using the archaeological data to reconstruct those architectural elements that he did not see.

Though our study proved Josephus' figures to be accurate for the width and the overall outlines of the Herodian moles, his claim for the water depth was exaggerated by far. To fully appreciate the uniqueness of Herod's moles, one has to consider that they were a daring engineering feat. They were laid in the open sea, off the shore, with no natural shelter from the full might of the surge. Taking into account what Josephus tells us about the unsuitability of the location, together with what we know about the local coastal processes, we can estimate the scope of the problems involved in the planning of these moles, and the necessary engineering solutions:

1. To establish a rather massive structure on a non-consolidated sea bed, over what was known to be ever-shifting sand.



2. To build moles that were strong enough to endure the constant pounding of the winter's storms. Their components needed to be well tied and of overall coherence, to avoid the familiar destructive process of segmentation and hollowing, as is seen in modern structures, due to the extensive suction of the retreating surge (Fig. 45).
3. To solve the inevitable phenomenon of the overlapping splash of sea water on the lee of the seawall. This would facilitate the proper storage and movement of goods on the inner part of the mole, as described by Josephus (Fig. 46).

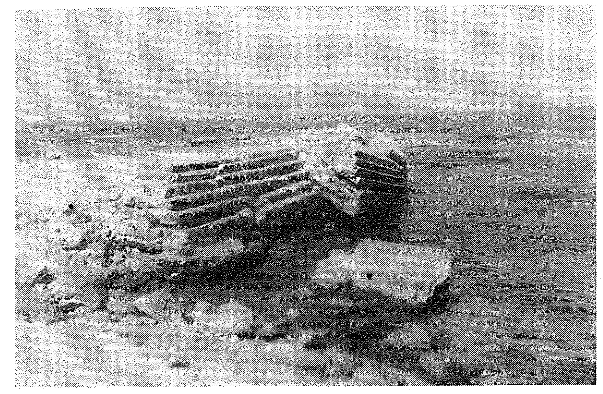

Fig. 45. A modern mole, built in 1961, in Caesarea, in an advanced stage of deterioration due to the undercutting and suction of the waves.

Fig. 46. The modern fishing wharf at Caesarea during moderate, mid-summer sea conditions.

4. To maintain proper water depth within the harbour basin and to keep it silt-free, in a place notorious for the constant shifting of wave-carried sand towards the shore. This was indicated by Josephus and is well known everywhere, in protected basins along the Mediterranean coastline.

While today such problems are dealt with by repeated dredging, the ancients did not have the heavy duty machines necessary for such an operation. Hence, preventative measures would have been applied as an imperative feature in the overall planning of the harbour.

Before continuing the detailed description as reconstructed from the archaeological data, of how the ancient harbour engineers dealt with these problems, let us quote from the Roman architect Vitruvius' canonic textbook *"On Architecture"*. This is to contemporary Herod's construction and concerns how such a structure should be built:

> *(2) But if we have no natural harbour suitable for protecting ships from a stormy sea, we must proceed as follows. If there is an anchorage on one side without any river mouth to interfere, piers are to be constructed on the other side by masonry or embankments in order to form an enclosed harbour. The masonry which is to be in the sea must be constructed in this way. Earth is to be brought from the district whicn runs from Cumae to the promontory of Minerva, and mixed, in the mortar, two parts to one of lime.*
>
> *(3) Then in the place marked out, cofferdams, formed of oak piles and tied together with*

*chains, are to be jet down into the water and firmly fixed. Next, the lower part between them under the water is to be levelled and cleared with a platform of small beams laid across and the work is to be carried up with stones and mortar as bove described, until the space for the structure between the dams is filled. Such is the natural advantage of the places described above.*

*But if on account of the breakers or the violence of the open sea, the supports cannot uphold the dams, then a platform is to be laid, as firmly as possible, starting from the edge of the shore or from a breakwater. This platfiorm is to be laid with a level top (towards the sea) less than half its width; towards the shore, it is to have a sloping side.*

*(4) Then towards the water and on the side of the platform construct margins projecting about one and a half feet level with the top mentioned above. Then the overhanging part is to the filled up underneath with sand and made level with the margin and the surface of the platform. Next, a pillar of the size appointed is to be built upon the levelled surface, and when it is finished, it is to be left to set for two months. The margin which keeps up the sand is to be cut away: thus the sand is washed away by the waves and causes the pillar to fall into the sea. In this way, as often as it is neccessary, the pier is carried further into the water.*

*(5) Where, however, the earth in question is not found, we must proceed as follows. Double cofferdams bound together with planks and chains are to be put in the place marked out. Between the supports, clay in hampers made of rushes is to be pressed down. When it is well pressed down and as closely as possible, the place marked out by the enclosure is to be emptied with waterscrews and waterwheels with drums, and so dried. Here the foundations are to be dug. If the foundations are on the sea bottom, they are to be emptied and drained to a greater width than the wall to be built upon them, and then the work is to be filled in with concrete of stone lime and sand.*

*(6) But if the bottom is soft the foundations are to be charred piles of alder and olive filled in with charcoral, as prescribed for the foundations of theatres and the city walls. The wall is then raised of squared stone with joints as long as possible, so that the middle stones may be well tied together by the jointing. The inside of the wall is then to be possible for a tower to be built upon it* (Vitruvius, *De Architectura*, 5.12.2-6).

Having the historical sources quoted, the problems presented, and the contemporary standards of engineering formulated, we might better comprehend additional facts which have been studied at the site.

Sebastos was planned at the site of the former inner harbour of Straton's Tower, the southern harbour of the town in the 2nd century B.C.E. To the south-west this artificially quarried basin was protected by a rocky promontory, over 100m. long and about 20m. wide, which was selected by Herod's architects to be the stem for the great mole (Fig. 47). The other, northern mole, was placed on the rocky shelf, some 300m. away, in accordance with the designated size of the main harbour basin (Raban 1989, 271-5).

The first feature to be built in the sea was probably an artificial island, at the place where eventually the tip of the main mole would be, some 500m. N-NW of the tip of the southern promontory and about 350m. due west of the stem of the northern mole.



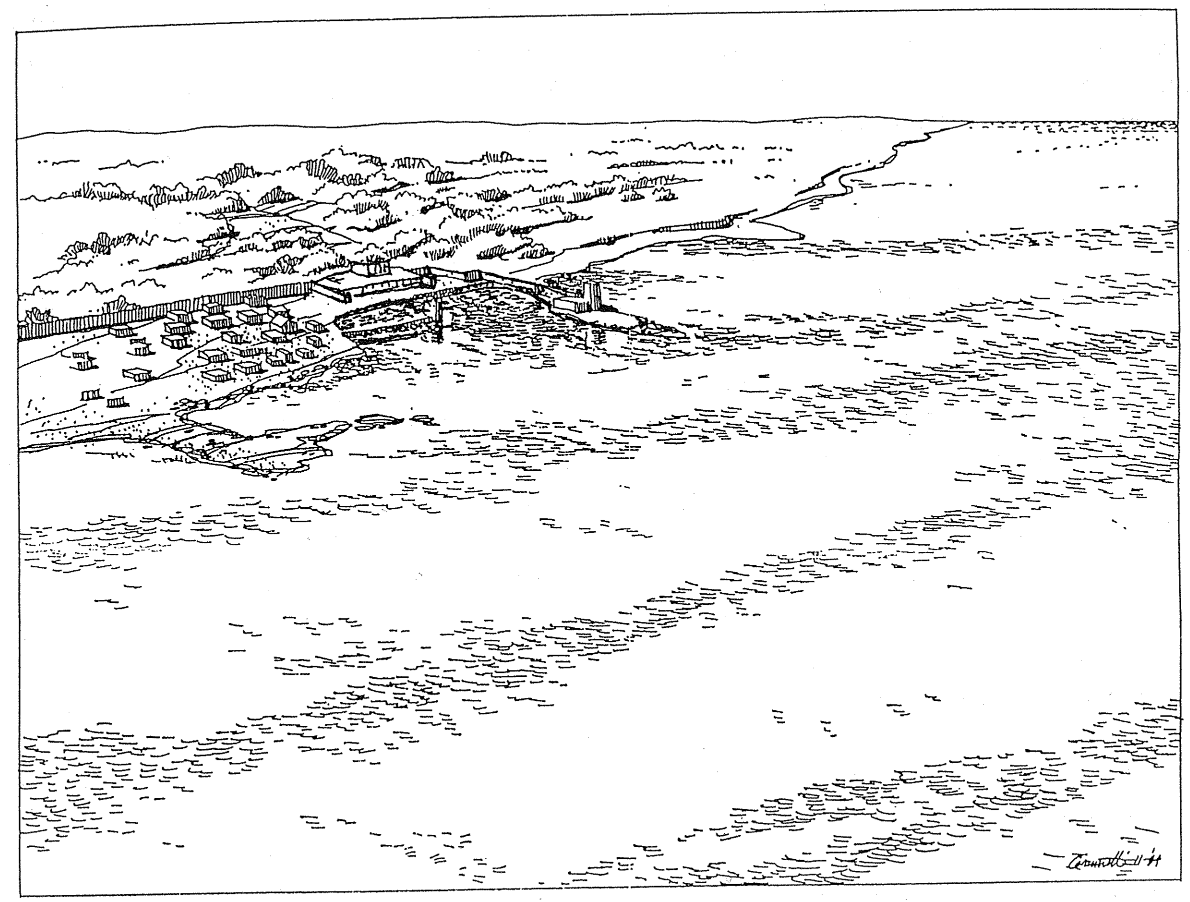

Fig. 47. Suggested reconstruction of the southwestern side of Straton's Tower, the site for Sebastos.

During the 1990-1993 seasons of field work we have discovered a series of wooden forms in which aggregated pozzolana had been packed, which served as a base for the island. One of these forms, of which the lower half has survived almost intact, was about 14×7m., with its original height just over 4m., which was probably the depth of the sea floor at the time of its construction. The wooden form was constructed on shore using the regular shipbuilding technique of that period. That is to say a shell-first system, in which side beams were laid, with composed boards of planks fastened by mortises and tenons attached to them as floor and side walls.

After the rectagular shell was completed upright, square section timbers, trimmed round, were added over the floor and along the inner face of the side walls. Cross beams and diagonal beams reinforced the structure, which had inner compartments (Fig. 48). It was filled up to about one third of its height with a mixture of volcanic ash, and was then left to dry and consolidate. Then, the form was towed to the site in the open sea, where it was moored by iron chains at all four corners. Additional loads of rubble and *pozzolana* in measured quantities, were then added to the caisson, from barges to cause its gradual, even subsidence, till it came to rest on a rubble cushion that had been made for it on the sandy seafloor. Another form would then be submerged next to the first one, and as close

Fig. 48. The inner cell of the wooden form in K/2 (1991 season) looking to the south.

as possible. The sides of the caissons were retained with piles of rubble, and the gap between the forms were filled with *pozzolana* packed in sacks. The combined platform, probably 20×40m. was covered with paving slabs, on which the largest tower was built, probably the "Drusion", mentioned by Josephus. This probably served as a lighthouse. An initial laboratory analysis suggests that both the wooden timbers for the caisson and the volcanic components of the *pozzolana* were imported from Italy (Vann 1991; Raban 1989, 191-4; Raban and Stieglitz 1993, 5).

An additional, artificial island of a similar type of construction was installed half way along the curved line of the main mole, where its course turns from west to a northerly direction (Fig. 49; Brandon, in press).

Another type of wooden form was used in a later phase, along the line of the spinal wall and the external course of the "Prokumia". After this construction had blocked the surge, a second artificial island was established at the designated tip of the northern mole. There, the wooden forms had a somewhat "lighter" mode of construction. We have studied such a form in area G. The caisson, with no planked floor, was rectangular with heavy, square slipper beams, on top of which double walls of mortised planks were inserted, fastened to a series of uprights which were installed on top of the slipper, 1.5m. apart (Fig. 50). While still on land the hollow between these uprights and within the double walls was filled with a fluid mixture of volcanic ash, fine grain tuffa and lime. When it dried the cement had a specific gravity of only 0.6. Then, the reinforced form was towed to the tip of the northern breakwater, moored in place with iron chains on sinkers, where it eventually subsided until it nestled on the rubble-cushioned seabed, due to the additional burden of water absorbed by the cement. At this stage the inner hollow within the frame was filled by aggregates of rubble, volcanic ash, lime and *pozzolana*, up to its rim at water level. When hardened, by absorbing the seawater, the form was used as a platform on which the superstructures were laid. This process of building caissons on the shore and installing them as components for artificial islands (Fig. 51) corresponds with the eye witness testimony of Pliny the Younger, as preserved in one of his letters, written half a century later at his vacation place at the Roman coastal town of Centumcellae (Pliny Minor, *Ep.* 6.31). During the second phase, a line of caissoned cement forms was laid at the designated course of the spinal wall; within its course, some 20m. away, a second parallel was built, along a designated line of the quay (or promenade, as Josephus named it). This innermost wall was built of ashlar blocks that were laid in tight courses of headers, in typical Phoenician tradition. When this wall reached above sea level, two confined hollow spaces were created: one along the curved line of the main mole, and the other within the confinement of the northern mole.



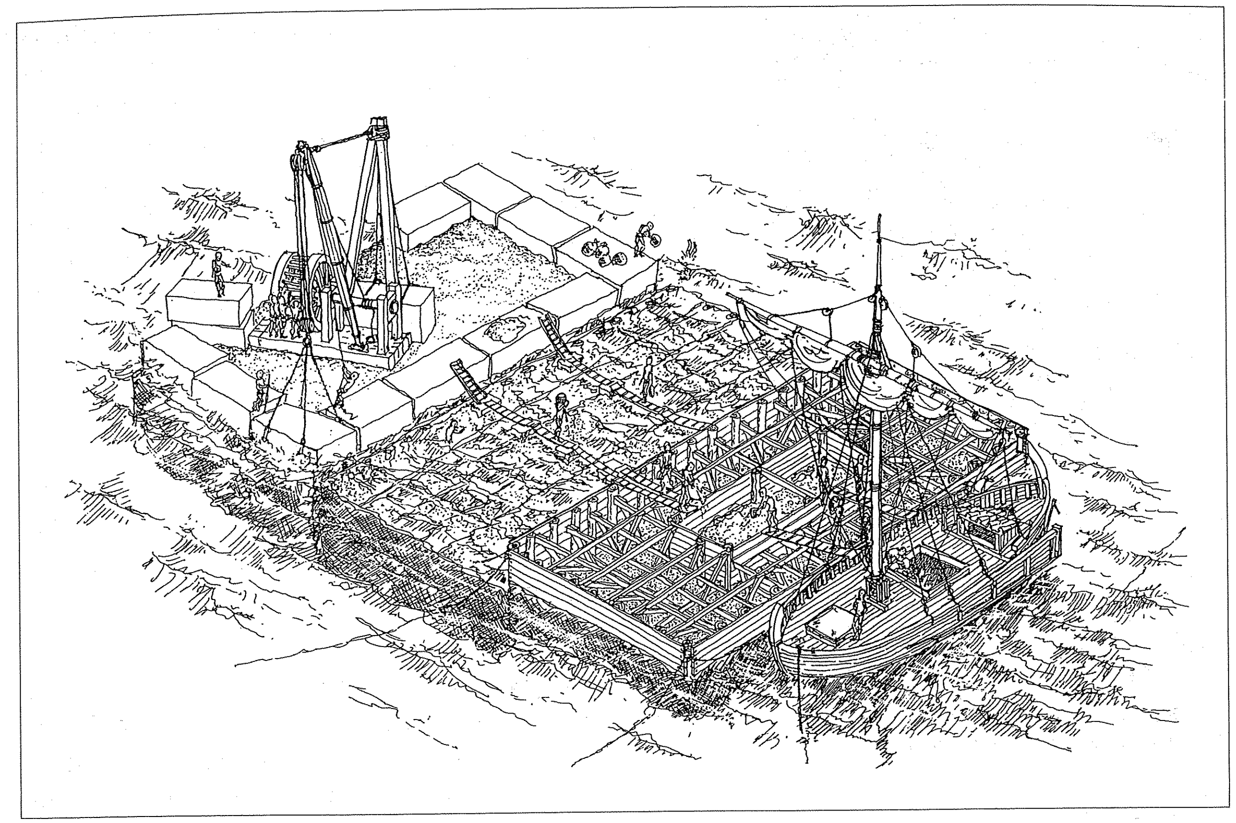

Fig. 49. Artist rendering of the artificial island at the tip of the main mole, under construction (C. Brandon).

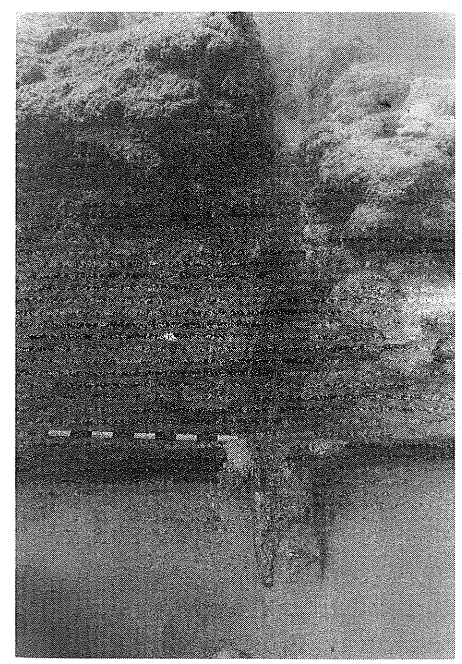

Fig. 50. The slipper beam of the wooden caisson at the tip of the northern mole, looking south.

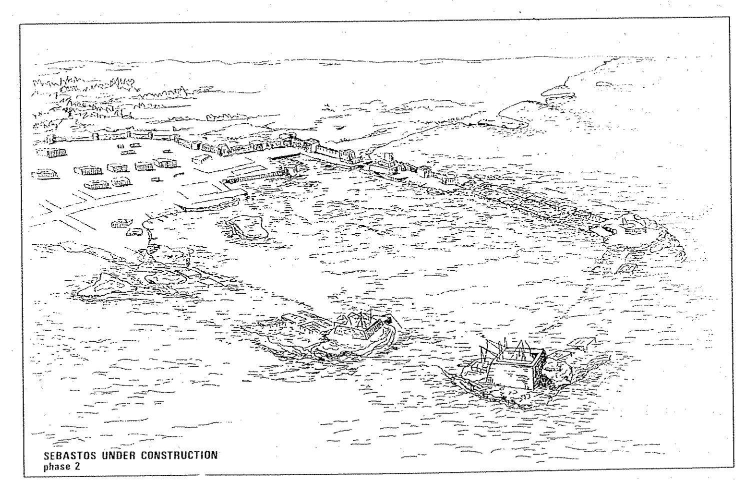


Fig. 51. Artist rendering of the artificial Herodian harbour under construction (Raban).

At this point work would have stopped allowing the elements time to contribute their constructive share in the project. Incoming waves, overrunning the spinal line, would break and deposit their load of sand within these hollows, which eventually silted up.

Probes made into these sand deposits have exposed the accumulated sediment layers of well-sorted grain sizes, reflecting altering wave energies during deposition. Five to seven layers of coarse sand, shingles and shells, representing deposition during severe winter storms, were counted in these probes, suggesting a duration of 2-3 years for the natural process of silt-up of these hollows. When filled with wave-carried sand the hollows were covered by a layer of rubble and captured sediments. This was then used as a base for the paving slabs of the promenade and floors of the storage vaults. The ashlars of the quay can be traced today along the lee side of the western mole for over 200m. The courses were built of standard size headers, 0.6× 0.6×2.3m. Such a structural mode would secure the endurance and integrity of the quay for long periods of repeated suction impact (Fig. 52).

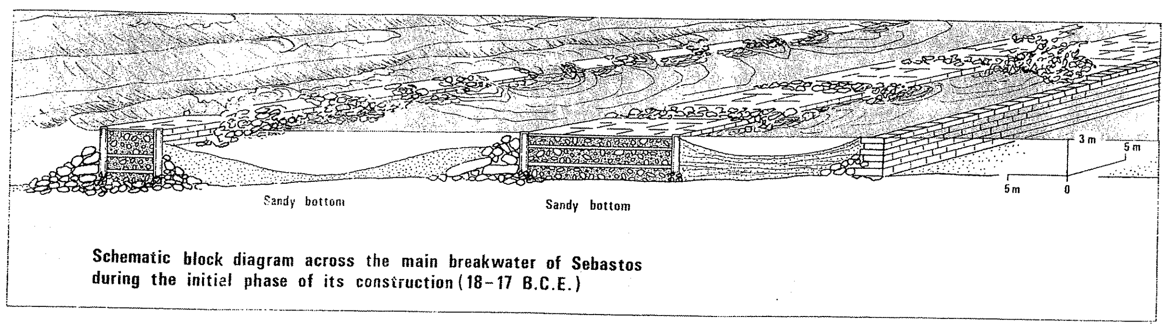


Fig. 52. Artist's rendering of the main Herodian mole under construction (Raban).

In the third phase the *Prokumia*, or *Prokumatia* was confined as a segmented line of subsidiary breakwater, relatively narrow and not much above the sea level. Being some 20-30m. outside the wall of the mole, it would cause the surge to break, leaving an ample settling area on its lee, in which the wave energy would be absorbed. The main role of this structure would have been to prevent sea water from splashing over the spinal wall and wetting the storage vaults that were in its lee. Breaking and settling the waves' energy away from the main mole would also prevent the destructive impact of undertrenching current at the base of the main mole. Being a segmented line, with openings for rip currents, it would stop water from being trapped in the settling area on the lee of the Prokumia which would then get silted up in the course of time. It appears that this unique subsidiary structure was added only to the main mole which faces the open sea and thus to the full impact of the surge. We found no remnants of such a structure along the northern mole, which faces the wind of the fairest weather, as Josephus attested.

Along the south side of the main mole, this extra breakwater still survives almost intact, though subsided by 5-6m., like the other components of the main harbour basin of Sebastos, due to what seems to have been a tectonic faulting (Raban 1989, 120-3).

With the completion of the third phase of construction, the harbour basin was closed and well sheltered from the surge. This would make it a settling body of still water, a terminal for the shifting sand, and for that reason it would gradually silt up. To prevent this, a flushing current was initiated, flowing out through the harbour entrance. This flush-



ing current was created by allowing extra water to enter the harbour basin through a series of shallow channels which crossed the main mole diagonally, along its southern side. Each channel's opening faced the surge with its base somewhat above sea level. Thus only the incoming waves were admitted with the constant inflow of water. Incorporated with a wider settling basin, these channels fed the harbour basin with additional quantities of silt free water. Vertical grooves for sluice gates, enabled proper control over the rate of inflow during different sea conditions. The additional quantities of went out through the harbour's mouth, thus flushing it thoroughly. Confirmation that the harbour basin had been flushed successfully was found by us on the sea floor. Within the main basin, under layers of wave carried deposits, there is a distinct thin layer of fine mud overlain by some first century sherds. Such sediment is typical of still waters and represents the time when Sebastos was intact and operational. The absence of sandy particles in the mud indicates that there was no silting of the harbour from the open sea (Fig. 53). Yet, when we started probing the seabed just outside the harbour mouth, we exposed a deposit over 2m. thick, made of mud, dirt, and all kinds of garbage from the harbour —a dumping site for whatever was carried away by the outflowing, flushing current. The range of artifacts found at this site, includes a score of clay vessels of fine Italian ware, wooden instruments, metal figurines etc. (*ibid*., 151-3; Holum *et al*., 1988, 91-3).

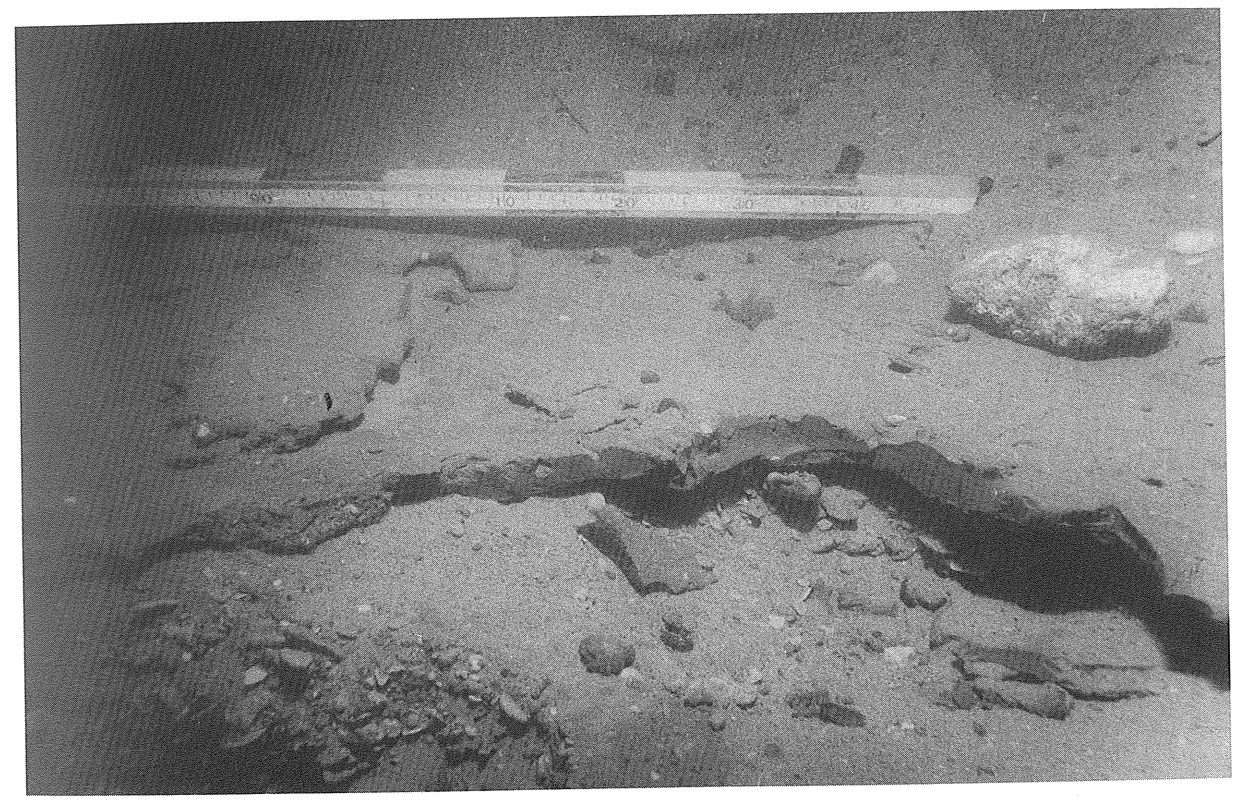

Fig. 53. The thin layer of fine mud - the original sea floor within the basin of the Herodian harbour, when it was intact and functioning.

The final stage in the construction of Sebastos included the upper structures, some of which Josephus saw and described. Among these features there was the spinal wall along the mole, its towers and the vaulted chambers within its confinement. Square slabs of cut stone were laid along the promenade. Subsidiary jetties divided the harbour into three mooring basins, one within the other. One such jetty was studied at the south side of the harbour. This jut off the north side of the southern mole, dividing the main (outer) basin from the intermediate harbour basin. This pier was constructed by parallel side walls of ashlar headers and was topped with cut stone pavers carefully laid over a sand fill. East of that pier, in the part of the harbour which did not subside (on the lee of the fault line) one can see the edge of the quay along the inner face of the south mole near its stem, retained on the rocky promontory. On the other side of the modern haven, under some later Roman buildings, there are a quay and a pier at the water level, both of which were subsidiary features within the intermediate basin of Sebastos. These structures were built according to the typical Phoenician tradition of tightly laid, long, slim headers, as was recommended by Vitruvius in the last paragraph, quoted above. It is amazing to realize how intact these structures still are after 2000 years, when a much more recent pier next to them, built less than 30 years ago, is already almost completely dismantled (Fig. 54; Raban 1989, 124-7, 151-3).

The inner, rectangular basin which had been dug out artificially over a century earlier, was incorporated as the innermost harbour basin of Sebastos, with a series of large vaults along its eastern edge. On top of these there was the temple dedicated to Augustus and Rome which overlooked the entire harbour.

Along the vertical face of the eastern edge of the inner basin we have exposed a line of marine fauna, *vermetides* and *ostraea*, which marks the sea level during the Roman period much at its present elevation. About half a meter above that line there is a pierced mooring stone jutting from the quay (Fig. 55).

Back in the main basin, at the tip of both moles, there are huge masses of tumbled blocks which come from the elaborate superstructures that crowned the harbour mouth. One of them, already mentioned above, is the "Drusion" which was on the northwest side.

On the tip of the north mole, along the eastern side of the harbour channel, there was a structure not much smaller than the "Drusion", which comprises huge rectangular cut stones, some of which are over 7m. long. Some of these blocks were fashioned at one end with a recessed scarf and hemispherical sockets, for the wooden shafts which supported the capstans on which chains were rolled up across the harbour's entrance (Fig. 56). In order that the blocks would withstand the drag when pulled by chains, they were fastened to each other by iron clamps fixed in place by molten lead. Solidified flows of lead were found at the foot of the tumbled mass of masonry under 10m. of water, indicating that the lead was poured after the blocks were laid in place in the water. This delicate work, as with the accurate enplacement of the blocks, would demand use of free divers working underwater, and probably using snorkels for breathing. Such professional divers were known in the Roman world as members of a guild of "*urinatores*" (Oleson 1976).

As Josephus tells us, there were statues crowning columns, which were set on top of upright rocks. Two such rocks found together, which would be on the right side of those sailing into the harbour, are clearly visible on aerial photographs (Fig. 57). They have been studied by us over several seasons (Area K), and were found to be made of artificial conglomerate. Their position made them excellent navigational aids, defining the western edge



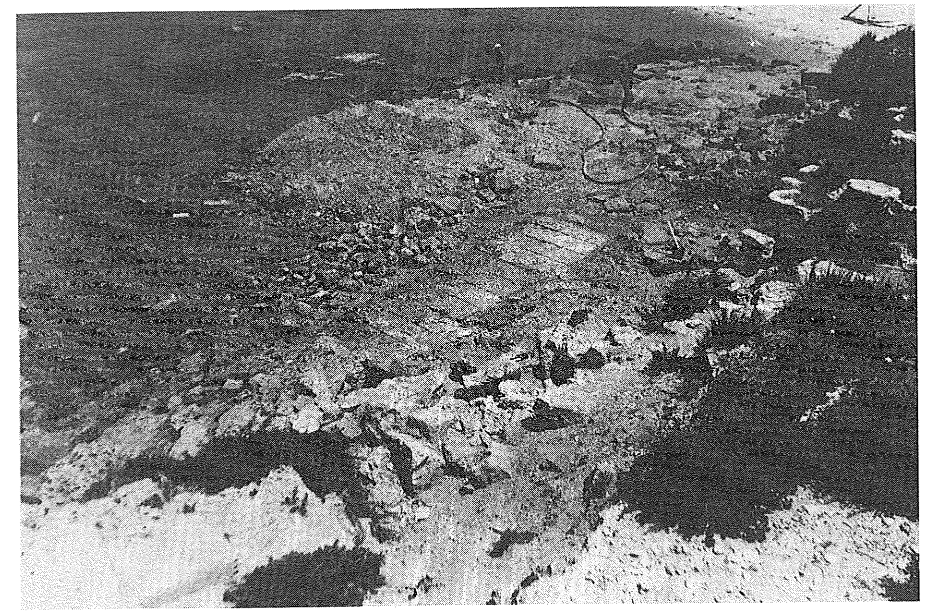

Fig. 54. Subsidiary quay of the Herodian harbour looking north.

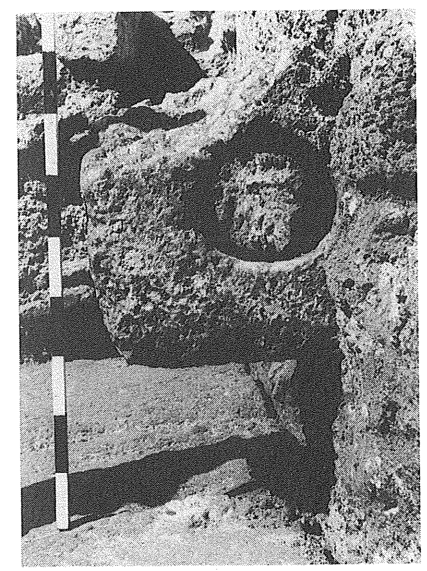

Fig. 55. The mooring stone in the inner harbour.

Fig. 56. One of the huge cut blocks which tumbled off the tip of the northern mole.

of the sailing course into the harbour. We found the matching "Tower" on the eastern side, buried in the sand, just north of the tip of the northern mole, where it should have been according to Josephus. It is a cement block of 15×15m., with some remnants of its wooden form surviving on the side (Area G). The towers on both sides of the entrance were settled on sandy bars, shallower than the nearby sea floor. It seems that the curved line of the main mole altered the way in which the wave-carried sand travelled along the near shore. The combined factors of the breakwater of Sebastos with the local wave climate deposited some of this wave-carried sand just outside the entrance to the harbour. The functioning, flushing current kept the harbour channel silt-free and defined the accumulation of sand bars on both sides of the harbour, in the open sea. The towers marked these bars, defining the navigational channel toward the entrance.

The in-sailing ships were guided to Sebastos from afar, by the smoke and the fire of the Drusion, and into it by the towers. They were then held at the tip of the northern mole, next to the control buildings of the harbour master, for the inspection of their credentials, cargo, bill of landing and taxation. Finally, they were tugged into their designated berth next to one of the harbour quays, for unloading, loading and even wintering when needed (Fig. 58).

The capability of Sebastos to offer wintering berths to large fleets of merchantmen made this harbour preferable to others in the Roman Empire and contributed much to its prosperity.

## 7. Conclusions

Herod's harbour at Caesarea was probably one of the best ever built in antiquity, yet there were others of similar sophistication. By the eve of the Roman era harbour engineers had already mastered the various building techniques necessary to cope with the elements and could properly plan and construct, when and wherever needed, full-scale harbours which were durable and could function all-year-round.

These marvels of ancient engineering, such as the Portus at Ostia, Leptis Magna, Caesarea and others (Paphos, among them), were usually too expensive to be built and maintained for an agency of less than imperial scale. For that reason they were few and were fated to fall into disrepair once commercial, maritime traffic declined below a certain level. The gradual process of privatization of sea-borne trade during the later years of the Roman empire and most of later antiquity would not allow the construction of additional harbours of such size and quality. Yet some technologies continued to be used, such as hydraulic concrete in wooden forms (Hohlfelder 1988). Later on, during the on-going conflict between the Arabs, the Greek-speaking Byzantines and Latin Europe, sea-borne trade diminished and harbours became naval outposts of military units. When the demand for a full-scale, modern harbour arose, rather late in the 20th century, shipping technology had changed so much that the technology of ancient harbour engineering was considered to be completely irrelevant to contemporary bulk carriers, cruise vessels and container ships. Yet, more recently, the trend —both in the Levant and in Cyprus— seems to be toward additional demand for sport marinas and small recreational harbours. For these harbours the lessons that can be learnt from the ancients are very relevant:

Properly laid breakwaters and moles might follow the techniques of cushioning the sandy sea floor with an ample layer of rubble, as the ancients had done —to avoid fluidation and eventual subsidence— as has just recently happened to some of the most modern marinas.

Properly installed flushing devices would enable these basins to retain proper water depths without constant dredging, as is currently the practice in almost every harbour and marina along the Levantine coast.



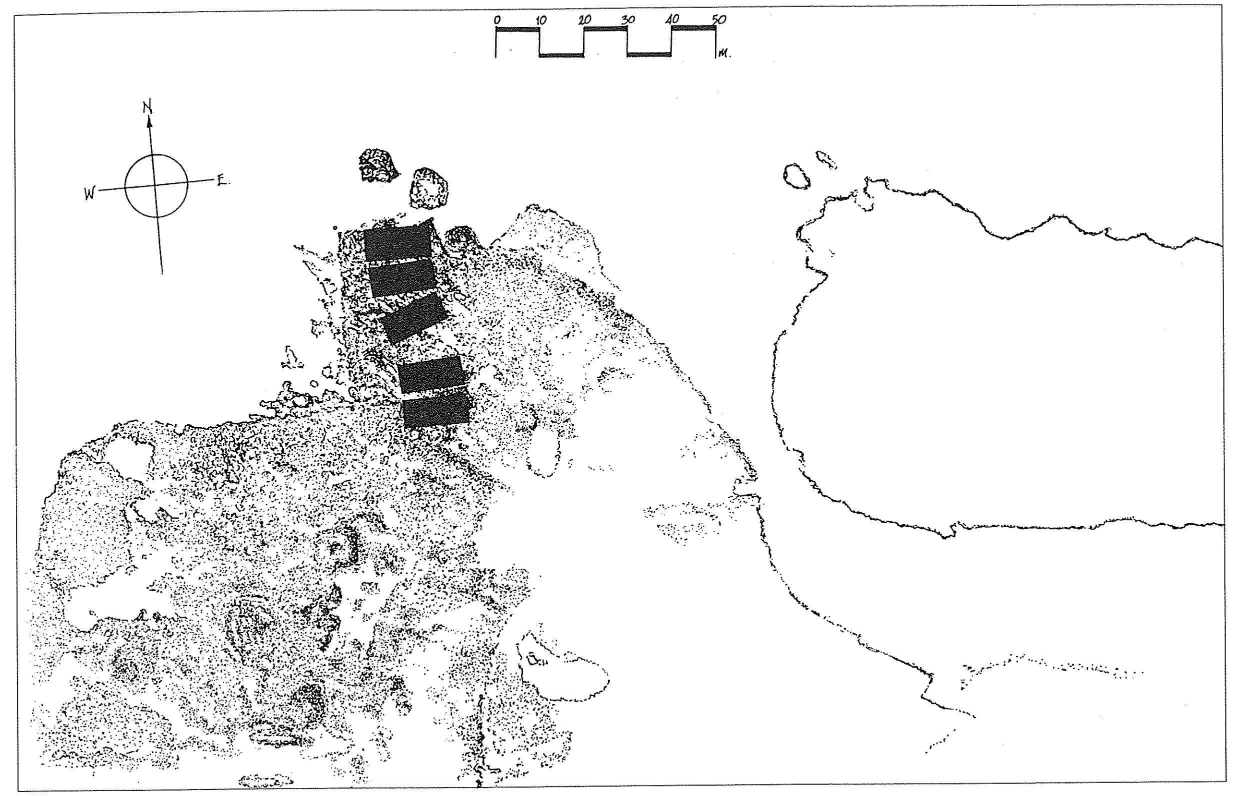


Fig. 57. Plan made after an aerial photograph , depicting the area around the harbour channel at Caesarea.

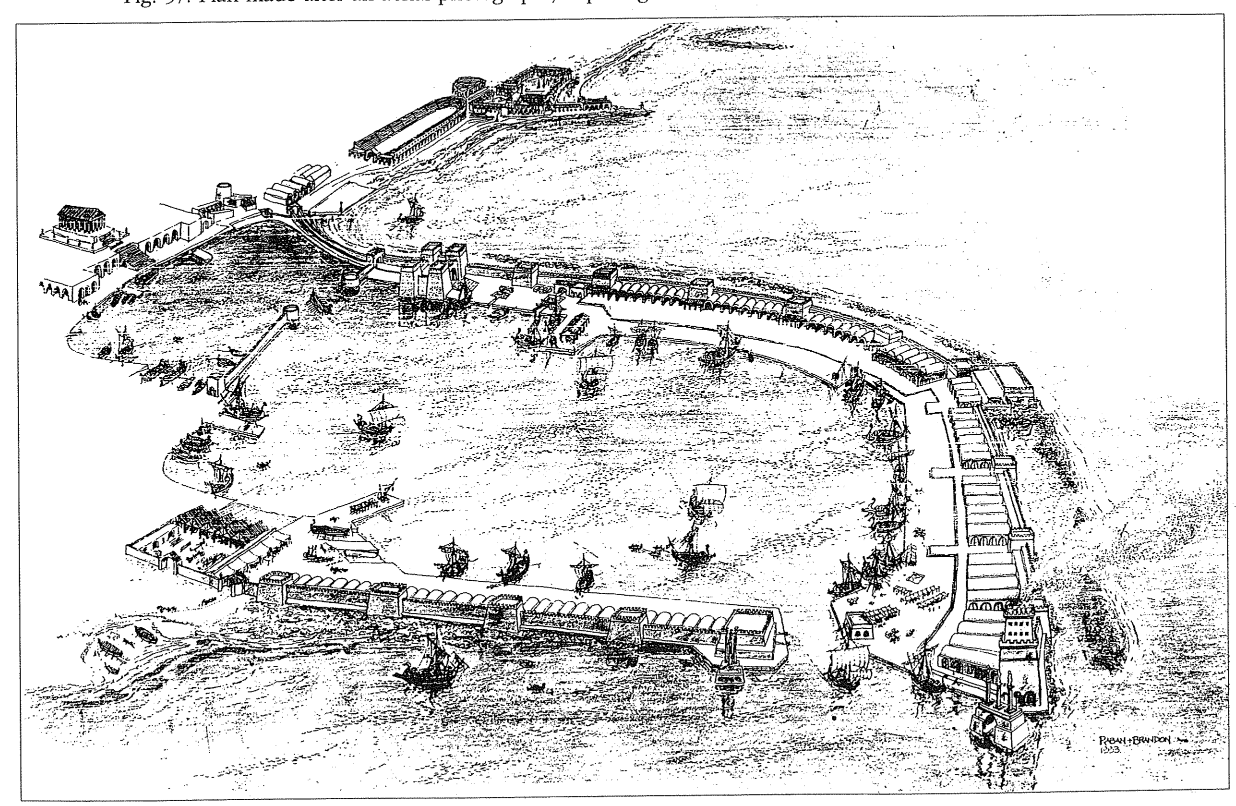

Fig. 58. Artist's impression of Sebastos, the Herodian harbour of Caesarea soon after its completion.

With the adoption of low-lying subsidiary breakwaters, such as the Herodian Prokumatia, as was recently done in the modernized harbour of Genoa, the moles could be used for shiftage and storage —freeing the densely built-up land-side of the harbours from the choking effect of port activities. There is a long and very stimulating heritage of maritime know-how in the East Mediterranean most of it still unstudied, and not fully comprehended. However, as we continue our research, there is an ever-growing respect for our predecessors and the impression that we are students of a truly applied science.

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## ΠΙΘΑΝΕΣ ΣΥΓΧΡΟΝΕΣ ΕΦΑΡΜΟΓΕΣ ΑΡΧΑΙΩΝ ΜΕΘΟΔΩΝ ΚΑΤΑΣΚΕΥΗΣ ΛΙΜΑΝΙΩΝ ΣΤΗΝ ΚΥΠΡΟ ΚΑΙ ΤΗ ΣΥΡΟΠΑΛΑΙΣΤΙΝΙΑΚΗ ΑΚΤΗ

(Περίληψη)

Μια γενική επισκόπηση και μερική μελέτη πλείστων αρχαίων λιμανιών, πρωτο-λιμανιών και αγκυροβολίων κατά μήκος της Συροπαλαιστινιακής ακτής και γύρω από τη νήσο Κύπρο, δίνει μερικές ιδέες που αφορούν την επιλογή της τοποθεσίας τους μέσα στο γενικό πλαίσιο της παλαιοτοπογραφίας τους, τη γενική αντίληψη του σχεδιασμού τους και την τεχνολογία που χρησιμοποιήθηκε για την κατασκευή τους. Αυτές οι ιδέες, αν υιοθετηθούν και προσαρμοστούν κατάλληλα, μπορούν να τεθούν σε εφαρμογή, όταν προγραμματίζονται σύγχρονες μαρίνες και μικρά λιμάνια στη γεωγραφική αυτή περιοχή. Μερικά από αυτά τα δεδομένα θα συζητηθούν στην παρουσίαση αυτή με έμφαση στα πιο κάτω θέματα:

1. Στη χρήση για λιμενικούς σκοπούς των εκβολών των ποταμών και των παράκτιων λιμνοθαλασσών με σεβασμό στο περιβάλλον, ώστε οι λεκάνες των λιμανιών να μη συσσωρεύουν λάσπη και τα κανάλια εισόδου να διατηρούνται ανοιχτά για ευρεία ναυσιπλοΐα χωρίς την ανάγκη συνεχούς εκβάθυνσης (αυτοκαθαρισμού).
2. Στον καθαρισμό των λεκανών των λιμανιών με υπερεκχειλίζοντα αυτοπροωθούμενα ρεύματα προς τη θάλασσα, τα οποία διαιωνίζονται από τα θαλάσσια κύματα.
3. Στην κατάλληλη ενίσχυση των θαλάσσιων τειχών και κυματοθραυστών που εδράζονται σε μη στερεό βυθό της θάλασσας, ώστε να αποφεύγεται η διάβρωση, η ρευστοποίηση και η τελική καθίζηση των κατασκευών.
4. Στη χρήση των κυματοθραυστών ως κύριων χώρων ελλιμενισμού και λιμενικής αποθήκευσης για εξοικονόμηση δαπανηρού χώρου στην ξηρά, και για τη διατήρηση ελεύθερου εκείνου του μέρους του λιμανιού που είναι ξηρά, για πολλές από τις δραστηριότητες της ναυσιπλοΐας. Αυτό επιτυγχανόταν με διατήρηση των μόλων στο υπήνεμο μέρος των κυμάτων και χρησιμοποίηση συμπληρωματικών κυματοθραυστών (με τη ζώνη καθίζησης εκτός).
5. Στη χρήση παράκτιων νησίδων, ανεξάρτητων κυματοθραυστών και ξύλινων κρηπιδωμάτων μέσα στη θάλασσα ως αγκυροβολίων και ασφαλών χώρων ελλιμενισμού για ποντοπόρα σκάφη, ώστε να κερδηθεί επιπρόσθετη χρησιμοποιήσιμη ακτογραμμή με πολλαπλή χρησιμότητα για τη ναυσιπλοΐα.