Maritime Tel Michal and Apollonia

Results of the underwater survey 1989-1996

Eva Grossmann

with contributors

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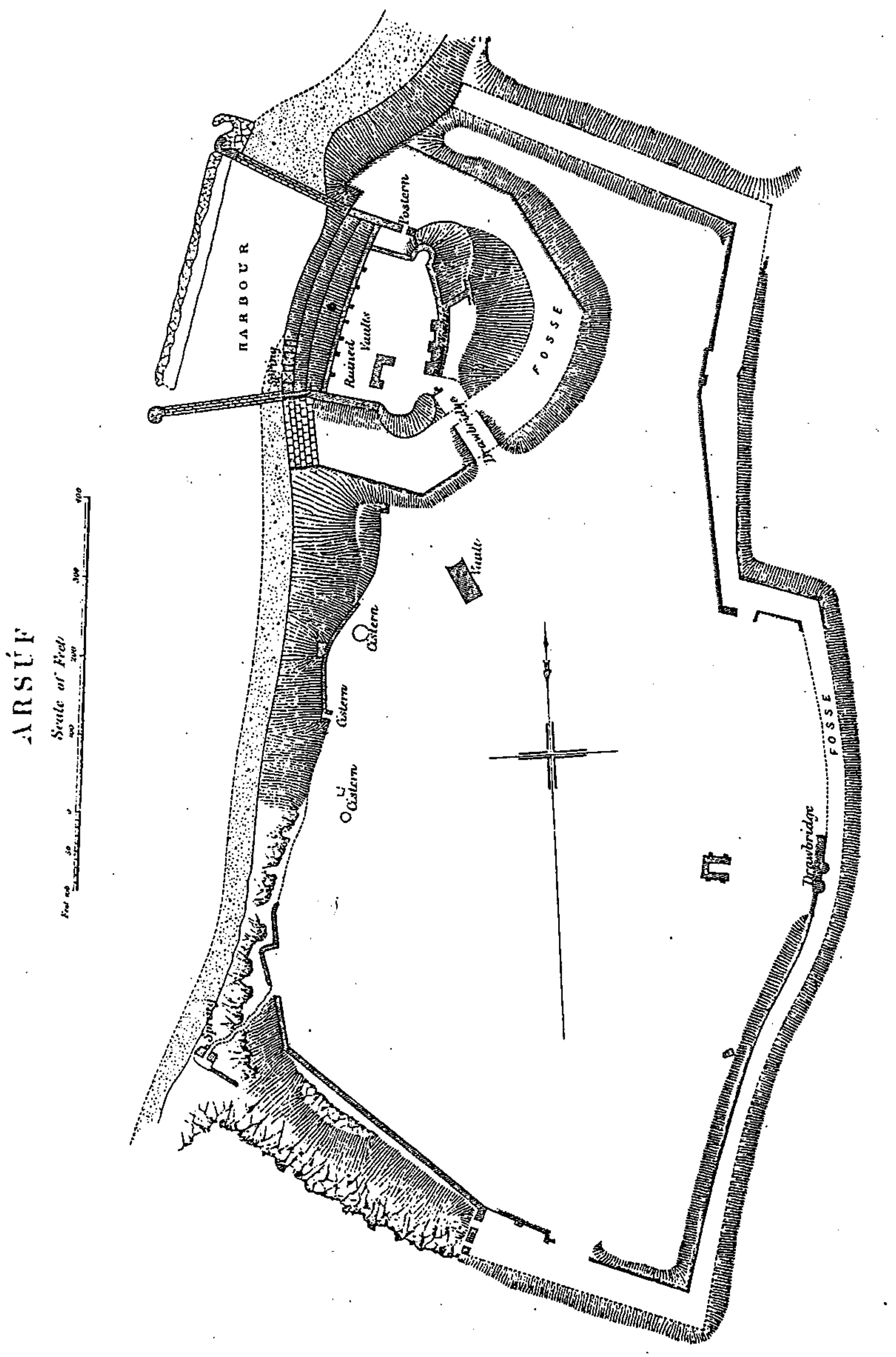


Fig. 6. Conder and Kitchner prepared a detailed plan of Apollonia's Crusader town during the 1872-1878 Survey of Palestine.

CHAPTER 1

HISTORY OF RESEARCH

1.1 Tel Michal

Tel Michal, also referred to as Tel Makmish, was first identified and investigated by the archaeologist J. Ory in 1922. Ory argued that the five nearby hills were the site of one large settlement (Fig. 17). Later explorations were once again conducted by Ory (1940), as well as by Hamilton (1944) and Danelius (1957). Ory and Danelius suggested that the site's high tell was already settled during the Bronze Age, a hypothesis proved correct by later examinations. Large scale excavations were conducted on the northern hillock in 1958 and 1960 by the Ha'aretz Museum of Tel Aviv and the Archaeology Department of the Hebrew University in Jerusalem, directed by N. Avigad (1960: 90-96; 1961: 97-110).

The excavation of Tel Michal was continued as part of a regional study of settlement patterns in the western Yarkon basin by Z. Herzog of Tel Aviv University. The project was initiated in 1977 and continued until 1982 (see Chap. 4). In 1979, the Department of Maritime Civilization at Haifa University was invited by Herzog to survey the inshore waters adjacent to Tel Michal and to seek evidence of a harbour. No indication of a harbour was found (Raban, 1979: unpublished).

1.2 Apollonia

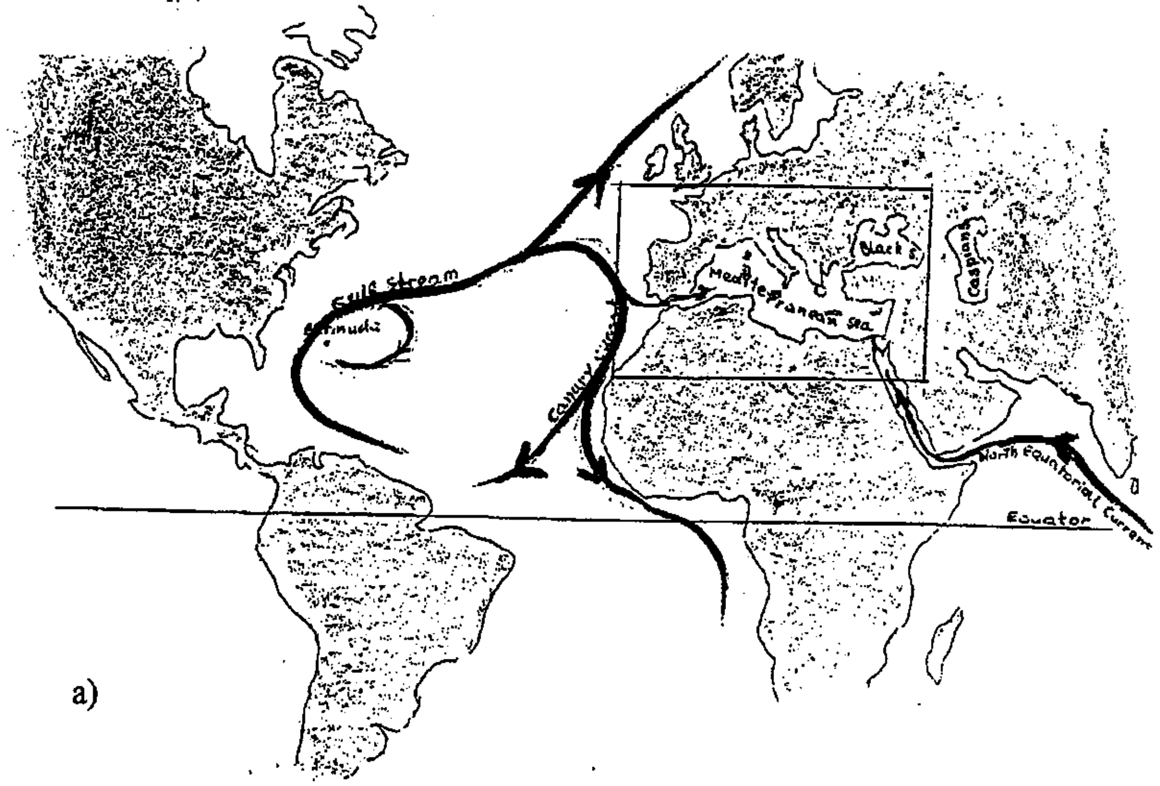
One of the first studies of Apollonia was undertaken by Herianus Reland in 1714. Reland collected information on the site and first identified it as Apollonia. In 1852 Ritter mentioned Arsuf as part of his greater geographical review of the Sharon coast (Ritter, 1852: 590).

Victor Guérin (1875: 375-382) provided a unique and detailed description of the town, including a description of the structures, massive walls with towers and the moat, which have since partly collapsed. Of particular relevance to this work is Guérin's reference to the so-called Crusader harbour as a "military harbour", because it was protected by the fortress above, had a postern and massive towers on both the northern and southern piers. The remains of the western breakwater of this harbour was described as covered by water and completely destroyed; the harbour was clogged with sand. To the south of this harbour lay a natural bay forming an anchorage, lacking piers, possibly a trade harbour (Roll & Ayalon, 1989: 23-24).

Conder and Kitchener (1882: 137-140) carried out exact measurements of the settlement and provided a detailed plan of the site, as part of their 1872-1878 Survey of Western Palestine (Fig. 6). During the same period Clermont-Ganneau (1876: 196-204, 372-399) came to the conclusion that the Arabic name Arsuf was derived from the Phoenician god Reshef, the Phoenician equivalent of the Greek god Apollo, according to Semitic and Greek inscriptions found in Cyprus (Roll & Ayalon, 1989: 25.)

The first excavation in 1950 was conducted by Ben Dor and Kahana (1951: 86-87) outside the city walls, as part of rescue excavations by the Israel Department of Antiquities and Museums. This excavation revealed a wine press and traces of a glass industry dating to between the Late Byzantine and Early Arab periods. In 1962 and 1976, further rescue excavations were conducted outside the city walls, revealing a Byzantine church with a mosaic bearing a Greek inscription (Roll & Ayalon, 1989: 26).

In 1977, Prof. I. Roll and E. Ayalon (1989: 26) conducted the first large-scale excavation of the site at three locations within the original city walls. In 1980 and 1981, Roll and Ayalon undertook two rescue excavations along the northern perimeter of the town. Since 1982 Roll has continued to excavate at various locations across the site. Roll was interested in determining whether the man-made elements of apparent maritime significance below the Crusader fortress were truly part of a harbour and whether an additional harbour or anchorage might be detected. A team from Haifa University was therefore invited to survey the inshore waters in 1979. Their conclusion was that the so-called Crusader harbour was not a harbour, but rather a lower castle, and that a natural anchorage existed farther to the south (Raban, 1979).



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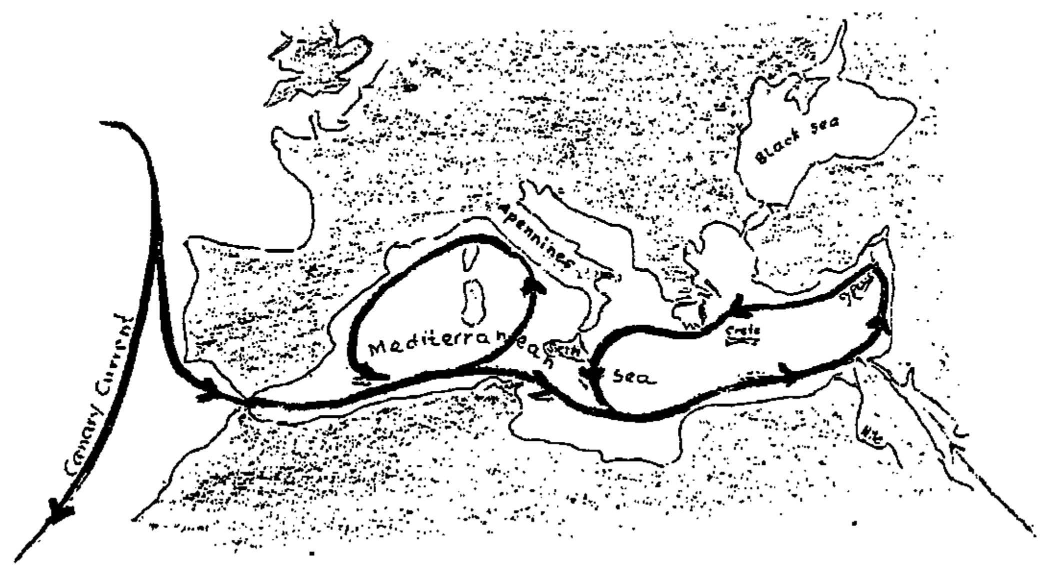


b)

Fig. 7. Currents: a) Atlantic ocean streams b) streams in the Mediterranean Sea

CHAPTER 2

GEOMORPHOLOGY OF THE SHORE

2.1 Geomorphology of the shore

The inshore waters at Tel Michal and Apollonia are subject to dramatic shifts in sediment cover, caused by waves and the longshore current which flows, except at three locations described below, northwards along the coast. Such phenomena affects the deposition of materials on the sea-floor and the ability to survey the site. This section will review aspects of geomorphology relevant to this work, moving from the general to the specifics of the Sharon Plain, where these two sites are situated.

To understand the changes that have taken place and which have affected the Israeli seashore during the last millennia, we have to consider the physical characteristics of the Mediterranean sea. The Mediterranean basin is supplied by the Atlantic Ocean and most significantly by the Gulf Stream (Fig. 7) which splits in the vicinity of the Bermudas into the North Atlantic Current and the Canary Current. A small part of the Canary Current enters through the Gibraltar opening into the Mediterranean Sea which is a closed basin. The Apennine Peninsula divides the basin into the western and the eastern section. In the western section the stream flows along the north African coast as far as Sicily, where again it divides into two currents. One remains in the western basin, flowing counterclockwise on the western side of Italy to the French coast and finally to the Spanish shore. The second current continues eastwards along the north African shore (Libya, Egypt), then the longshore current extends northwards along the eastern Mediterranean shore to Israel, Lebanon, Syria, Asia Minor and back to the Apennine Peninsula (Bowditch, 1977: 742). The Mediterranean Sea, with its negative balance, is also nourished through the Bosphorus by waters from the Black Sea. The yearly sea-level fluctuations on the Israeli shore may reach 70-80 cm (resulting from seasonal changes of tide), the daily tide fluctuation is low, approximately 30-40 cm (Champion, 1980: 96-97; van Dorn, 1974: 137ff; Mart, 1990: 99-104).

The Israeli coastline extends 180 km from the south, from the Gaza Strip, to the Lebanese border in the north. The seashore line is almost a straight line, except for the area of the prominent Carmel Mountains and the Haifa Bay. *Kurkar*[1] formations of the Quaternary period dominate the coastal ridge. The *kurkar* rocks lie in parallel strips on the continental shelf, along the seashore and inland. On the Sharon coast they are eroded at the base by wave wash and this causes the sea to advance continuously inland (Gill and Almagor, 1999: 27). Due to a lack of drainage, the inter-ridge valleys were swampy until quite recently. The ridge along the shore prevents sand from penetrating inland, except where rivers had created eroded gaps in the ridge and enabled sand penetration (Neev *et al.*, 1987: 3-4). This phenomenon appears at Tel Michal, where sand penetrates extensively through Nahal Gelilot (Goldsmith & Golik, 1980: 149). These ridges are also eroded due to wind action and wave abrasion at the toe of the cliff, as at Apollonia, and by rain washout of the soft *hamra* layers which can be perceived at Netanya (Goldsmith & Golik, 1980: 149). Nir (1973 & 1984) reports that the average retreat of the coastal *kurkar* cliff has been 2-4 cm yearly for the past 6,000 years. When in recent years the exploitation of beach sand for construction began, the average yearly retreat of the cliff also grew larger. However, the longshore current rebuilds the seashore, flowing from the south towards the north, with the sand from the River Nile's Delta which is composed mainly of quartz and small amounts of biogenic fragments and heavy minerals extending as far north as the Haifa Bay (Nir, 1984: 74). It has been noted that this current begins depositing sediment from the south, therefore the sandy beaches are the widest there. To the south of Tel Aviv the beach can reach a width of some 50 m. At most sites between Tel Aviv and Apollonia the beach is some 15-20 m wide and at Apollonia the waterline almost touches the cliff (Fig. 8). Along the Sharon's *kurkar* cliff, between Apollonia and Hadera the beaches are relatively narrow, mostly only a few meters wide and sometimes non-existent.

A considerable part of the Israeli Mediterranean coastal sand originates in the Nile Delta's coast transported by the longshore current along the shores of Northern Sinai, the Gaza Strip and Israel. The supply carried by local rivers and deposited in estuaries is minute and almost negligible. The major local sources are from *kurkar* rocks which erode and add sand to the coastal system. The fine contents of *kurkar* rocks enter into a suspension which are later deposited in

[1] *Kurkar* is a local term for a carbonate-cemented quartz sandstone of various degrees of cementation typical on the Coastal Plain of Israel and its shallow shelf, with inter-bedded soft layers of *hamra* - red sandy loam.

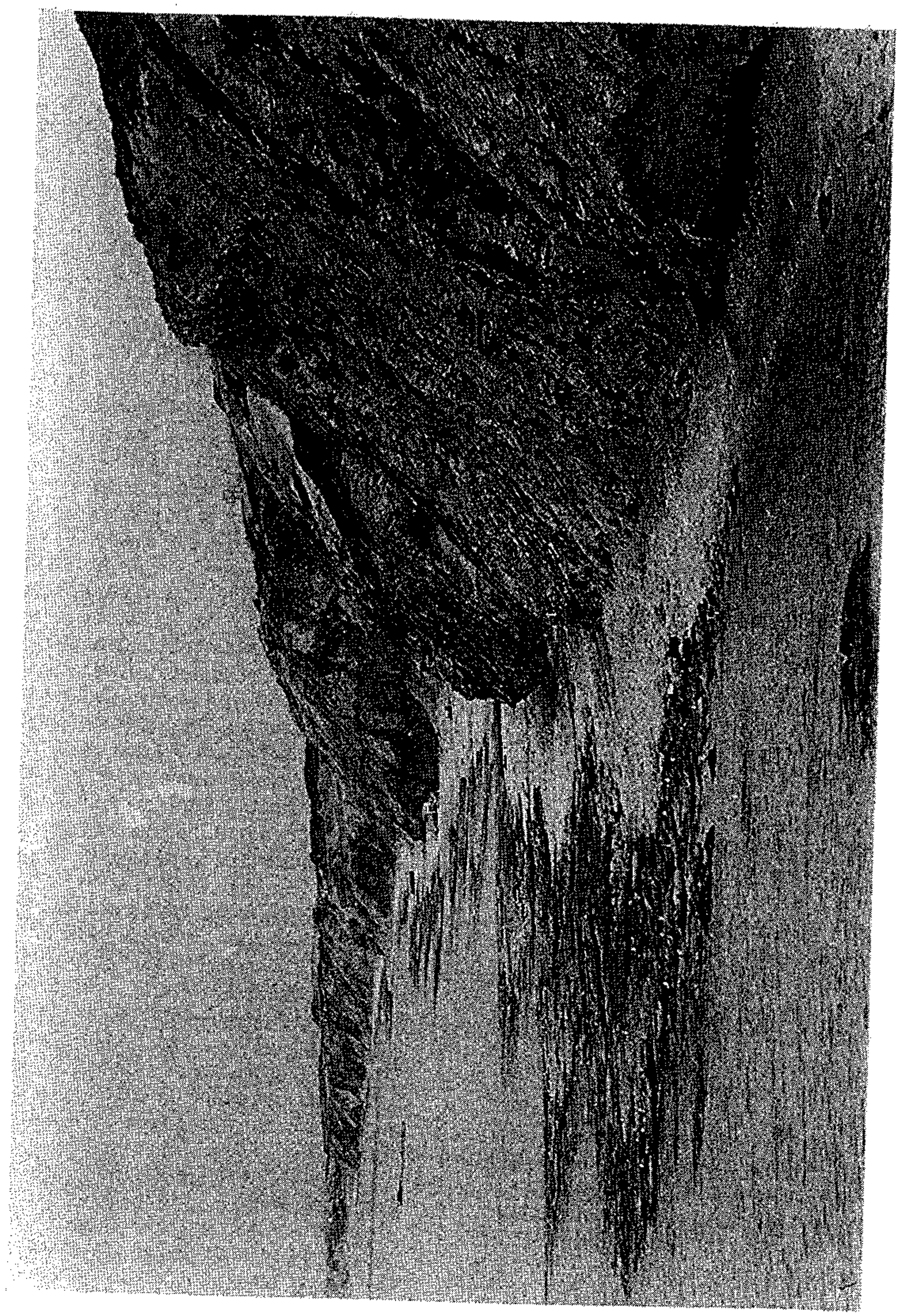


Fig. 8. View to north from Apollonia. Notice the narrow beach.

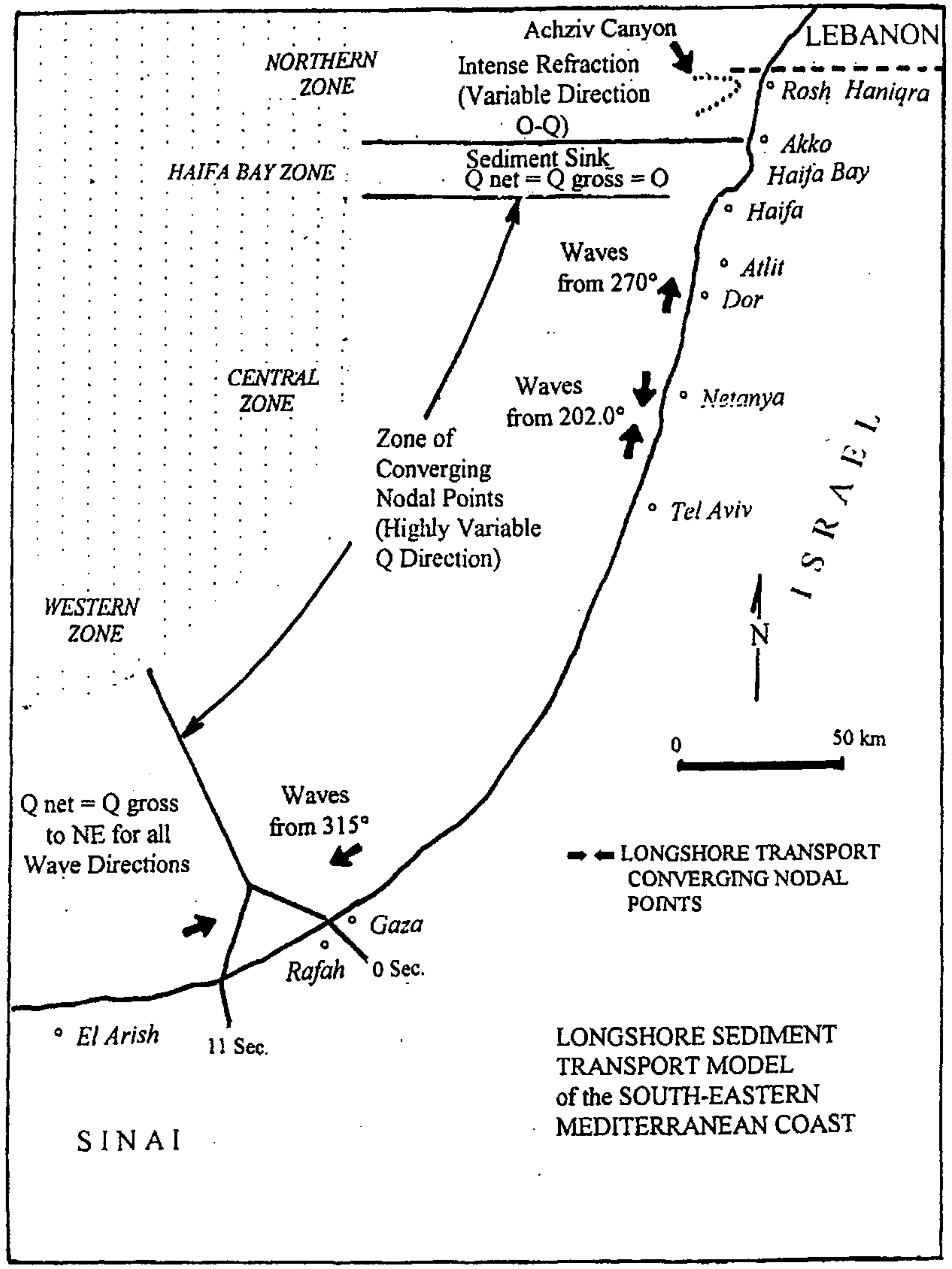


Fig. 9. Longshore sediment transport model schematically presenting the change in location of converging longshore transport nodal points with change in wind direction and period (From Goldsmith & Golik, 1980).

deeper water off the sandy "belt". This "belt", according to Kennett and Nir (Kennett, 1964: 287; Nir, 1973 & 1984: 72-4), is some 3-5 km wide, reaching a depth of 20-25 m. At that depth there is a transitional zone to the fine muddy sediment regime, therefore most of the sand found there is of fine and very fine grades.

The beach is the most dynamic of all the marine environments. Located at the intersection of sea and land, the sediment is constantly changed and by surface waves and tides. The turbulence violently stirs the sdiment and transports it between the upper beach limits and deep water (onshore - offshore transport of sediment). This obstructs marine archaeology and causes delays as we ourselves experienced during our survey. We observed that the sand could be redistributed very quickly, particularly in the Tel Michal area, changing the sand accumulation differential up to +/-2 m daily. When the sand deposition was great, all features observed on previous dives might be completely covered, when it was low, new features could be revealed. The company performing sample drilling for the construction of the Herzlia marina, found the sand layer fluctuations to be even greater than we experienced, reporting changes of +/-3 m (S. Samuka, 1989, pers. comm.). This caused considerable operational problems while surveying, photographing and measuring underwater. Since the continental shelf was still dry land during the last ice period (the Würm period), it can be suggested that the deposition of sand began by the glacio-eustatic rise of the sea level (of approximately 30 m) at the beginning of the Holocene, some 10,000 years ago (Nir, 1984: 72). According to Slatkine & Rohrlich (1963), the age of the deposition and accumulation of the sands on the Israeli seashore is not more than 11,000 years BP and its upper layer, as dated by stratified archaeological finds, is younger than 3,000 years. The settlements along the shore reached their peak at the end of the Neolithic and at the beginning of the Chalcolithic period, 6,000-5,000 BP (Gophna & Ayalon, 1989: 17-19).

At three points off the Israeli shore the current flows in a reversed, north to south, direction creating three longshore transport nodal points which change their location according to the direction of the incoming waves. These nodal points (Fig. 9) are situated approximately at Gaza, south of Netanya (close to Apollonia) and at Dor (Goldsmith & Golik, 1980: 165 ff). The location of the nodal points provide a framework for sediment transport, influenced by different wave conditions. The existence of nodal points also explains the seemingly reversed placing of harbour entrances in ancient times, which actually allowed current-driven desilting of a harbour basin. This feature occurred at Apollonia (see below Chap. 8).

River estuaries are semi-enclosed coastal bodies of water freely connected to the sea. Here sea-water is gradually diluted by freshwater from the land, mixed by tides and winds. However, permanent maintenance of the channel together with the freshwater flow cleans the immediate outlet of the estuary, and this was the reason why river outlets were used as harbours in ancient times. It is suggested that the ancient harbour at Tel Michal may have been located in the estuary of Nahal Gelilot, on the inland (eastern) side of the high tell, accessible by a channel. This theory is discussed below (Chap. 6).

Beachrock is found along many Israeli beaches. It is composed of cemented sand, *kurkar* fragments, shells and forms relatively quickly. Some deposits even contain bottles and other materials dating from recent decades. Beachrock is usually located at sea level, and forms an abrasion platform, sloping at an angle of about 4 degrees into the sea. Torbjorn's explanation (1969: 57) that beachrock examined in the Aegean Sea ranged "from incipient, where the grains hardly cohere, to advanced, where the original pore space between the grains is mostly filled by cement" thus demonstrating that "when the grains are firmly bound, abrasion by wave action cuts through both grains and cement and leaves a smooth upper surface." Small tombolos, lagoons and bays may form seawards from beachrock (Goldsmith & Golik, 1980: 149-150). Precise dating of beachrock is difficult, although biogenic material, such as shells can be dated by radiocarbon analysis (Alexandersson, 1972: 203-223; Hopley, 1986: 165). Very often beachrock breaks into rectangular shapes, resembling pavements. This phenomenon of rectangular shapes also occurs to the north of Apollonia's "Crusader Harbour".

2.2 Sea level changes

Sea level changes in the Eastern Mediterranean have been discussed by many scientists. Bloch (1963: 89-98) and Lewis (1971: 243) have suggested depicting the sea level changes as a graph based on the examination of European Mediterranean shorelines and on the dating by radiocarbon analysis of plant and animal remains from the period 237 BC to AD 1970 (Fig. 10). Muckelroy (1978: 77) has discussed a possible dating method for sea-level changes by studying a vermiform gastropod which only forms as solid matter precisely at a sea-level interface and can be dated by correlating it with associated artifacts or by radiocarbon analysis. Also Erol and Pirazzoli (1992: 321) based their research on sea level changes on marine biological evidence, such as vermetids, oysters and calcareous algae, supported by radiocarbon dating of these marine samples. There are examples of the use of marine molluscs in the recognition of earlier sea levels and by reference to all the above methods. But these only enable differentiation between littoral, shallow and deep water environments (Petersen, 1986: 129, 141-2). At Dor, vermetids were found on submerged architectural structures and could be used for dating, but none were identified at Caesarea (Flemming *et al.*, 1978: 42). Evidence provided by such shells at Apollonia was contradictory, suggesting contamination by sources that could not be determined. After consulting staff members of the Department of Biology at the Hebrew University in Jerusalem, it was felt that these findings should be left for later study by scientists with more specialized expertise.

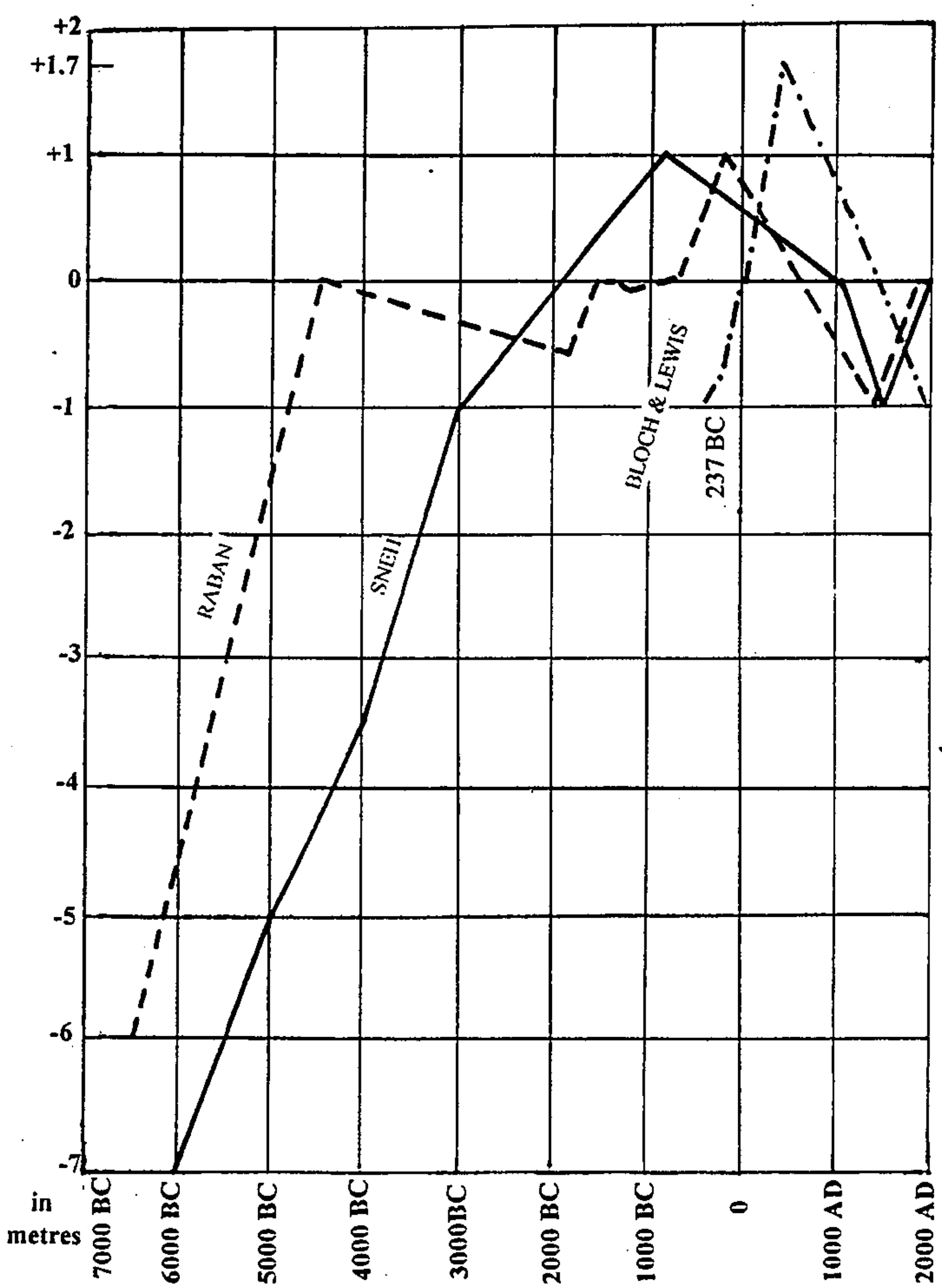


Fig. 10. Comparative table of sea level changes: according to Bloch (1963) and Lewis (1971), Sneh's table (1981) and Raban (1983 b: 122).

The topic of sea-level changes is controversial. To establish the sea-level curve at different periods during the last seven millennia remains problematic. This has direct implications for the study of the various settlements and their relations to the sea and land. Inference about sea-level heights, sometimes accurate to within 10-20 cm, is possible from a study of man-made shore-dependant installations. Critical evaluation of evidence is, however , necessary and debate over its interpretation will frequently follow. Indicators are varied and plentiful: harbour floor pavements, harbour breakwaters, mooring stones, slipways, fish ponds, fish pond rinsing trenches, salt evaporating ponds and purple-dyeing facilities which occasionally needed to be fed by sea water.

A particularly interesting example for the rising of the sea-level is illustrated by the settlement of Atlit-Yam, dating from the Pre-Pottery Neolithic and Chalcolithic periods which is now approximately 10 m below sea level (Galili & Nir, 1991: 103). The most important discovery in this village is a sub-sea well which is cut into clay soil. This well provided information about sea-level rises from the latest stages of the post-glacial transgression to the early Holocene. "The data from the well are in good agreement with reconstructed levels in other parts of the world during the eight millennium BP." (Nir, 1997: 148; see Fig.11).

According to Flemming, Raban and Goetschel (1978: 33) the 40 km long coastline, from Akko at the northern section of the Haifa-Qishon graben, to the south of Hadera, is characterized by its significant tectonic activity and has therefore been thoroughly explored for sea-level changes. Research along this coast has been carried out by Raban (1983 b: 122 ff) and Raban and Galili (1985: 321-356), who suggested that during the Byzantine period the water level was approximately 1 m higher than today, and during the Crusader period 1 m lower (Fig. 10).

Nir and Eldar (1987) and later Nir (1997) excavated ancient water wells dated to between the Late Bronze Age and the Ottoman Period (ca. 3,100-200 BP), along the coast between Ashqelon in the south and Akko in the north, in an attempt to establish the sea-level during the past 3.5 millennia. These wells are located up to 1 km inland. Nir and Eldar's study was based on the dependence of the ground water table on the sea-level, each change of which is mirrored in the ground water table. The ancient water level is marked in most wells by a brown-black horizontal stripe 3-6 cm wide, encircling the well's interior and usually 40-60 cm above the solid bottom of the well. Evidence was found that ancient ground water levels along the Israeli Mediterranean coast were - and still are - the direct result of eustatic changes of the sea-level and/or of tectonic changes. Due to the lack of natural water sources, such as springs and rivers, water has been exploited by digging ground water wells of relatively shallow depth (as mentioned above at Atlit-Yam). The wells were lined with local *kurkar* stones and sometimes reinforced and strengthened with plaster which preserved them in a relatively good condition. Though they are still intact, they are no longer being used.

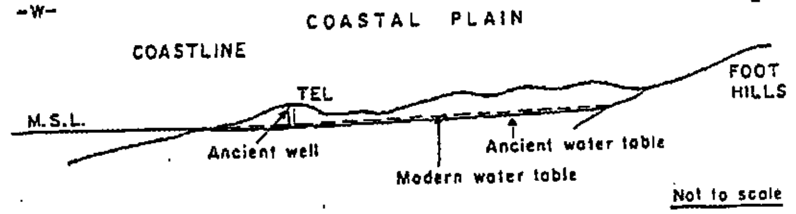
Nir and Eldar (1987) found up to 1.6 m sea-level changes in the water levels throughout the past 4,000 years. Galili and Nir (1993) working on the Atlit-Yam Pre-Pottery Neolithic village showed that the sea-level at ca. 7,900 years B.P. was some 16 m below that of present. Nir and Eldar (1987) also found indications that the area studied has been essentially tectonically stable for the past 3,100 years. By correlating ground water levels of ancient wells, from the Middle Bronze IIB to the Crusader period, with past fluctuations of the sea (their drainage basin), they established that sea-level changes along this coast did not exceed +/- 1.5 m (Fig. 11). The data they collected indicated a gradual sea-level rise of about 1 mm yearly, between the Persian and the Crusader periods, which would have resulted in a total rise of about 1.5 m. However, according to measurements of Nir and Eldar, the water level rose and fell again at various locations, so that no uniform level changes along the investigated length of coast may be assumed. Nevertheless, they concluded that during the Byzantine period the sea water level was approximately 0.5 m higher than today (Fig. 11). As the sea rose during the Holocene, the environment was affected and changed. During the Middle Bronze Age fortified towns were constructed on the *kurkar* rocks at locations where fresh water was available, near river and wadi outlets, on the sites of former settlements. This was the period when towns like Ugarit, Gebal, Achziv, Akko, Tel Megadim, Dor, Tel Michal and others were at their peak (Heltzer, 1979). According to Raban's study (1983 b) of ancient man-made shore structures, the sea level was approximately 1 m higher during the Byzantine period and 1 m lower during the Crusader period compared to today's sea-level (Fig. 10).

Flemming (1972) is convinced that the changes in sea level during the Holocene period were caused by local or regional tectonic movements and not by eustatic changes. This is also confirmed by other findings, as at Caesarea, where local changes may be detected (Neev, 1975), and at Dor, where Sneh (1981) found a north-south fraction which caused differences in the height of a clay layer to be some 1.5 m between the north and the south of the harbour. Sneh's table illustrates the changes in sea level during the last 6,000 years and is reproduced in Fig. 10.

Neev and Bakler (1978) have argued strongly that vertical movements are still continuing along the shore between Caesarea and Ashqelon. According to their study in this part of the seashore downwarping occurred after the Byzantine Period, reaching below today's sea level, and after some decades rose above it. Even today it has not reached its maximum level yet (the peak before it sank).

2.3 Climatic changes

Pollen analysis is often used to establish the differences in the climatic changes of specific regions. A comparison of pollen diagrams from different levels of archaeological excavations, within a deposit, allows for the identification of



Schematic east-west profile along coastal plain of Israel showing ancient and present water tables in relation to sea level.

TABLE 1. STATISTICAL DATA ON 8 WELLS ON THE COAST OF ISRAEL, FROM DOR IN THE NORTH TO ASHQELON IN THE SOUTH

Location	Period	Age (B.P.)	Distance from present shore (m)	Elevation of top of well above msl (m)	Elevation of old water table (m)
1 Dor*	Late Bronze	3500-3200	5	4.0	-1.0
2 Dor	Byzantine	2000-1400	400	3.0	0.0
3 Mikhmoret	Persian	2550-2300	25	3.3	-1.4
4 Tel Qasile+	Persian	2550-2300	1800	14.0	+1.8
5 Yavneh Yam	Hellenistic	2300-2000	25	1.5	-0.7
6 Ashdod (Tel Mor)	Hellenistic	2300-2000	1000	23	+2.0
7 Tel Ashqelon**	Byzantine	2000-1400	200	17.3	+1.0
8 Tel Ashqelon	Crusader	850-700	200	17.0	+0.5

*Dug by Raban (1983); estimated to be 3100 B.P.
+Dug by Mazar (1983); estimated to be 2400 B.P.
**Because of collapse at the bottom, digging of this well was stopped at 14-m depth, but another 2 m of debris was present; therefore, its water mark could not have been much higher than the present ground-water table.

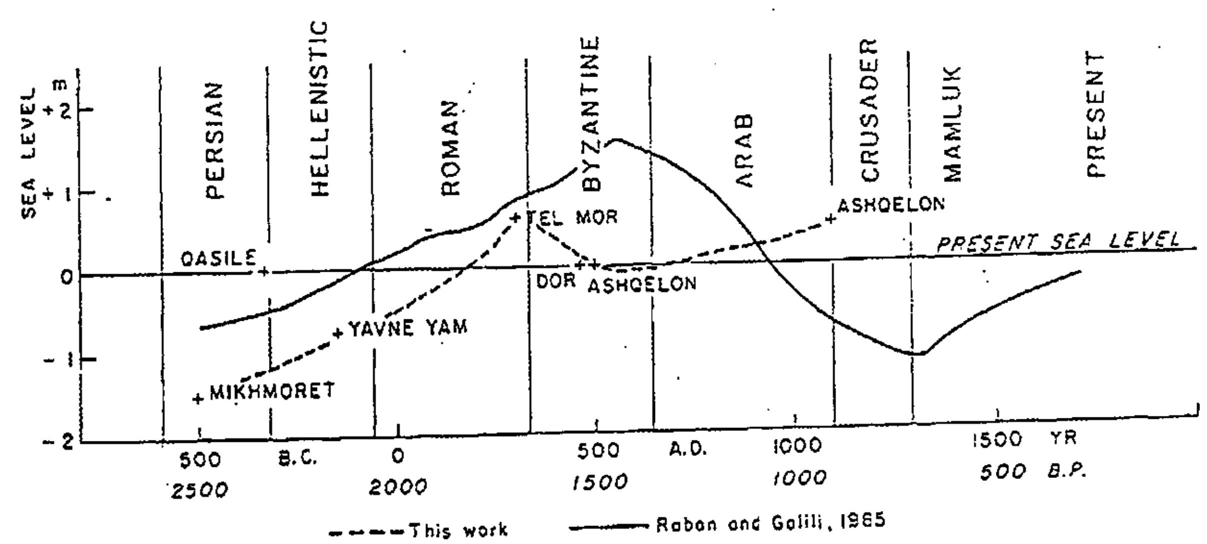


Fig. 11. Comparative graphs of sea level changes as researched by Nir-Eldar and Raban-Galili (Nir & Eldar, 1987).

changes in the environment. Such a study may provide an indication of the type of paleo-flora and can also be used for accurate dating by isotope decay studies. Horowitz (1978) pointed out certain problems which must be considered when dealing with pollen, such as its tendency at being moved through various archaeological levels by water and gravity. Furthermore, tree pollen may be transported by wind much farther than herbaceous pollen.

Horowitz (1978: 58) has studied the pollen in Israel and found that in the course of various periods there were differences in arboreal pollen. This is especially marked by increases in oak and olive pollen percentages between 2,400 and 2,300 BC (end of the Early Bronze period) and 2,100-1,100 BC (Middle Bronze to Late Bronze and Early Iron periods), and lower percentages from 650 BC (Persian period) onwards to 850 AD (Mameluk period). He has argued that during the periods of high peaks in the arboreal pollen curve the Levant enjoyed a more humid climate than today's, with summer rains creating richer vegetation and resulting in a more stable soil surface.

The climatic changes had a strong influence on the settlement pattern of Israel. The "desert line" was more to the south than today during the Chalcolithic period (4th millennium BC), the Early Bronze Age and Middle Bronze Age II (3rd - 2nd millennium BC), and to some extent also during the Late Bronze Age. Horowitz believes that rain fell all the year round.

Horowitz's research (1978) shows that when settlement began at Tel Michal (during the Middle Bronze Age), the climate was more suitable for the inhabitants enabling them to use their hinterland for agriculture and rich pasture. In the Persian period, when the settlement of Tel Michal came to an end and the building of Apollonia commenced, the inhabitants were more dependent on trade than on agriculture[1].

[1] This can be also understood, *inter alia*, from the Prophets, who described Israelites going to Egypt to purchase agricultural products (such as: Isaiah 19:19; Jeremiah 2:18, 42:14). During Hasmonean rule, trade between Egypt and Israel was lively. Not only to support the Jewish soldiers who were situated in Elephantine and guarding the Egyptian border with Nubia, but also to exchange goods (Eilat, 1977: 129 ff).

CHAPTER 3

COASTAL PROCESSES ALONG THE CENTRAL COAST OF ISRAEL, THE BEACHES AND THE KURKAR CLIFFS OF APOLLONIA

BY Y. NIR

The central section of Israel's Mediterranean coast belongs to the terminating stage of the Nile Littoral Cell, commencing east of Alexandria, at the western border of the Nile Delta, and ending at the Akko promontory, a total distance of almost 700 km. The major sediment transported from Ethiopia by the Blue Nile is the Nile lutite (very fine sediment) composed mostly of silt and clay particles. The coarse fraction of this load is composed mainly of mineral quartz. This imported Nile sand is the main component constructing the present Israeli coastal plain. The supply to the Nile Littoral Cell ceased to function as a direct result of the damming of the Nile at Aswan in 1902 with the Low Dam and in 1964 with the High Dam. Natural sorting processes carry the fine fraction of the Nile sediments to the deep waters of the eastern section of the Levantine basin, while the sands, belonging to the coarse fraction are left along the shores and in the shallow shelf zone. Long-shore currents, mainly with an easterly trend, deliver these sands along the Nile Delta coasts, towards northern Sinai, to the Israeli shores, terminating at the northern tip of the Haifa Bay at the Akko promontory.

A secondary, somewhat less important sources of sediments along the central Israeli coast is that produced by the erosion of the coastal *kurkar* cliff (*kurkar* is a local term for carbonate cemented quartz sandstone of Pleistocene age). This cliff contains, besides the typical *kurkar* sandstone mentioned, semi-consolidated soft brown *hamra* soil layers (*hamra* is a local term for red loam). A cover of calcarenitic hard layer is found in many sections as a cover-layer. On top of the upper part of the *kurkar* section, along many sections, an undulating loose sand forms small dunes. The entire *kurkar* section supplies through erosion, mainly sand, silt and some clay to the coastal system. These are naturally spread out by water columns according to their energetic tolerance: the coarse sediments retained along the coast and in shallow water, while the fine sediments are spread along the sandy strip westwards towards the deep water.

The local rivers, the so-called wadies, supply the beaches with a minute quantity of sand. These originate in carbonate rock or alluvial soil terrains, both poor in clastics (sand or pebble components). Resulting during rainy winters, their supply is composed of just a very low proportion of the coastal sand.

The cliff of Tel Arsuf (Apollonia) is a typical sea-cliff that was eroded in the undulating coastal *kurkar* ridges representing fossil Pleistocene sand dunes (Fig. 12). This section belongs to the Sharon cliffs extending from Rishon le-Zion in the south up north to Nahal Hadera. The cliff around Tel Arsuf varies with elevations from 15 to 35 metres. They are quite unstable, suffering from frequent collapses and very severe erosion through marine, atmospheric and terrestrial processes. The marine process affects the base of the cliff during stormy seas, while the cliff-face suffers from rainwater, wind and sea spray.

According to Nir (1973), the cliff has receded under natural processes during the past 6,000 years reached some 2-4 cm/yr. Remnants of ancient *kurkar* ridges may be found under shallow sand layers or are exposed on the sea floor up to several hundred metres offshore (of the present shoreline). These relicts represent the outlines of the abraded ridges "cut" by sea agents and on many sites these features may be seen and identified as such. Later, Nir (1992) showed that human activities such as beach-sand quarrying, construction of artificial offshore structures, etc., resulted in the receding of the cliff up to 20 cm/yr. and more.

The top of the cliff south of Tel Arsuf reaches heights of between 35 to 40 metres. This cliff is composed of only one "layer" of *kurkar* formation, of the white-yellow cross-bedded rock type. Due to its relative uniformity, as compared with many other *kurkar* sections, this section is more resistant to erosion. The cliffs north of the tell are less uniform, somewhat higher, composed of, in addition to the cross-bedded layers, also some soft *hamra* and gray sand layers.

At present, the Tel Arsuf site protrudes some tens of metres more than its neighbouring northern and southern cliffs. Eight hundred years of cliff erosion could have cut a much larger cliff section. On the other hand, this structure practically has not suffered much erosion since its construction. The reason for the slower erosion at this specific point could be a result of some artificial sea-walls and small breakwaters (or perhaps the combination of the two). Although no offshore constructed walls have as yet been found, this possibility should also be considered, as many dressed and undressed stones are found all around the Arsuf marine sites.

The explanation for the stability of the cliff of the archaeological site might result from the special conditions prevailing here. The shallow and mostly rocky sea floor with the probable addition of artificial structures, weakened wave action and energy to the site in general, and to the harbour specifically. It should also be mentioned that during the last few decades there has been some accelerated erosion of most of the sea front of the tell, with many parts of the Crusader wall collapsing on to the beach.

Fig. 12. Parts of the Crusader wall which collapsed on to the beach (by Y. Nir).

CHAPTER 4

HISTORICAL BACKGROUND OF TEL MICHAL AND APOLLONIA

4.1 Historical Geography

Tel Michal and Apollonia are situated on the coastal strip towards the centre of the Sharon plain. Their location was based on strategic reasons (Rainey, 1989: 10-11). The name Sharon appears in the Egyptian document *List of Towns of Thutmose* III, No. 21, in the el-'Amarna letters (EA 241: 4) and in the Bible (1 Chron. 5: 16). Saronis is an ancient Greek term for "old hollow oak" used by Pliny (N.H. IV, 18). Rainey (1989: 10) does not reject the possibility that there is some generic connection between the word Sharon and the oak tree, since an oak forest originally must have existed along the western ridge of the central Sharon. Descriptions of the Sharon landscape are available from different historical periods. The sarcophagus inscription of Eshmun'azar, King of Sidon (mid- 5th century BC) refers to the area: "... the Lord of Kings, gave us Dor and Joppa, the mighty lands of Dagon (= grain lands), which are the Plain of Sharon,.." (ANET II 662, 1975: 229). Josephus (*War* I, xii, 2 [250]; *Antiq.* XIV, xiii, 3 [334]) and Strabo (XVI, ii, 27, 28) both allude to the 'forest' along the coastal plain south of the Carmel. According to Gophna and Ayalon (1989: 25), the so-called Sharon forest "is mentioned up to the Early Roman period, again from the Crusader period onward, and in the descriptions of travelers of the last century. On the other hand, there is no mention of the forest in historical or geographic records from the Late Roman, Byzantine, or Early Arab periods". This is substantiated by wood samples taken from Tel Michal and Apollonia (Roll & Ayalon, 1989: 216).

During the Byzantine period a large part of the oak forest was cleared for agriculture. It is likely that a significant quantity of the oak wood was used for the glass industry, which flourished in the region and required large quantities of charcoal for its furnaces (Gophna & Ayalon, 1989: 25). During the Crusader period references are made to a forest east of Arsuf, in which Salah-a-Din's army hid before the "Battle of Arsuf" in 1191, waiting for the army of Richard the Lion-Heart (Archer, 1889: 146). Pococke (1771, 2: 74), an 18th century pilgrim, described the estuary of the Yarkon River as being full of tree trunks ready for export to Egypt, indicating an abundance of timber in the region at that time. The presence of a forest along the length of the Sharon coastline was noted by Jacotin and in the maps produced by the Palestine Exploration Fund during the Survey of Western Palestine in the 1870s (Conder & Kitchener, 1881-3; Har-el, 1977: 79-82).

4.2 The Occupation of the Settlements

The Tel Michal - Apollonia region extends approximately 12 km from north to south, and 7 km from east to west. In the immediate vicinity of the sites, *kurkar* ridges are situated parallel to the coastline, each approximately 2 km further east from the other. Only the troughs between these *kurkar* ridges, consisting mainly of *hamra* soil, proved suitable for agriculture in antiquity. According to Gophna and Ayalon (1989: 17) "numerous wine presses found in archaeological surveys and excavations testify to the extent of viticulture" which flourished in the region. There were also extensive swamps located east of the second *kurkar* ridge. Excavations at Tel Michal and Apollonia have revealed large quantities of animal bones of sheep, cattle, wild animals and fish bones as well. During the Byzantine period the swamps were drained (Fig. 13) and most of the valley was utilized for agriculture (Roll & Ayalon, 1989: 180).

The first signs of inhabitants in this region are represented by flints, mostly microliths, of the Epipaleolithic Kebaran culture. These were found primarily on the *kurkar* ridge at Rishpon and Herzlia B (Gophna & Ayalon, 1989: 19). A small Chalcolithic site (5th millennium BC) was discovered at Kibbutz Shefayim, and some flint tools were found there. These were scattered widely over the area and hence indicate that it served mainly as a site for pasture and hunting. To the west of Apollonia, on the coastal ridge, ostrich egg shells were found, believed to date to the same period (Gophna & Ayalon, 1989: 19) and east of the Crusader fortifications ceramics and flint tools, also dated to the 5th-4th millennium BC, were discovered (Roll, 1997: 78).

During the Early Bronze Age (4th millennium BC) the settlement density of the Sharon began to increase. No dwellings were found of that period, but hearths and pottery, apparently from temporary encampments, were discovered. Such a site was found at Apollonia. In the foothills to the east of the Sharon, villages like Tel Aphek and Tel Qana had already developed town life. It is likely that the inhabitants were grazing their flocks along the coast and were also practically hunting. The area was mainly exploited for agricultural purposes (Gophna & Ayalon, 1989: 19). At the end of the 3rd and the beginning of the 2nd millennium BC, small villages were established along the Israeli coast, suggesting that the coastal road was being exploited for the first time as an important highway. It was probably an important transport route for the Asiatic tribes, the Hyksos,

Fig. 13. A tunnel, approximately 175 m long, was quarried during the Byzantine period through the *kurkar* rock to drain the swamps between two *kurkar* ridges eastwards from Tel Michal and Apollonia.

who ruled Egypt during that period (Gophna & Ayalon, 1989. 21).

During the Middle Bronze Age IIB period, port cities were established and fortresses constructed along the coast of Israel. These include Tel Mevorakh, Tel Michal, Tel Gerisha, Jaffa, Tel Mor, Ashdod and others. The beginnings of international trade at Tel Michal can be traced back to this period. Among the imported objects discovered at Tel Michal were pottery vessels from Cyprus, the Aegean Sea and Egypt. Gophna and Ayalon (1989: 21) concluded that "The first settlement at Tel Michal was limited in size, but in view of the many imported vessels found and the lack of agricultural settlements around the tell, it may be surmised that the site was a harbour fort or a trading station, part of a larger political unit that developed marine trading activities" and thus they did not exploit all of its agricultural potential.

At the beginning of the New Kingdom in Egypt, there was a rise of wealth, prosperity and trade that spread to its north-eastern neighbours (Kenyon, 1979: 166-168). Maritime trade prospered during the Late Bronze period with the development of commercial centres such as Ugarit which accommodated ships from all over the Eastern Mediterranean. The right to use the marine and commercial facilities of such centres was granted to all merchants, without regard to political provenance. This could only be the outcome of political stability and peaceful coexistence, such as must have existed during the El-Amarna Age. The evidence referred to above suggests a lively trade along the coast during the Middle and Late Bronze period (Linder, 1971: 317-321).

The most important commodity during the 2nd millennium apart from agricultural products, was copper, comparable to today's iron and oil. The two great powers in the region at that time were the Egyptians and the Hittites, separated by the Mediterranean Sea and with land contact via the eastern coast of the Mediterranean basin, through Israel, Lebanon and Syria[1]. The region was strategically important to Egypt, Hurrians and the Hittites. Numerous texts confirm that Israel was Egypt's main source of agricultural supplies. One of them is the list of towns of Thutmoses III, who conducted a military campaign to Israel and Syria every year. He established supply ports for his armies along the Syro-Palestinian coast. These towns served as naval bases that were ruled by local princes, vassals or Egyptian officials, and developed into flourishing centres of maritime commerce. These settlements could thus become detached politically from their hinterland and were entirely based on maritime trade. During the time of Akhnaton's rule the Egyptian influence weakened, because the king was occupied with political and religious changes within Egypt (14th century BC) which remained weak until the reign of Seti I at the end of the 14th century BC (Alt, 1968: 111 ff).

The struggle for power between the Hittites and Egypt over the rule of the eastern shore of the Mediterranean resulted in many military clashes which caused the economy to suffer. In order to achieve a certain economic stability in the Near East, the Hittite king Hattusilis III signed a peace treaty with Ramesses II (beginning of the 13th century BC), bringing economic prosperity to both powers (Goetze, 1965: 261 ff).

During the 12th century BC several changes occurred in the political order of the Near East, when various tribes began exerting pressure on the existing powers (Dothan, 1989: 59-70). The Hittite Empire disappeared and in its place came the ancestors of the Phrygians. At about the same time, the eastern shore of the Mediterranean was invaded by the Sea Peoples. After the great battles (in the latter half of the second millennium BC) Ramesses III, Pharaoh of the 20th Dynasty, settled them in strongholds, denying them entry into Egypt and thus kept Egypt's economy stable (Kenyon, 1979: 207, 212 ff; Dothan *et al.*, 1992).

With the arrival of the Sea Peoples and the coming of the Iron Age, Tel Michal was abandoned (Herzog *et al.*, 1989: Fig. 1.3 p. 9)[2], while a flourishing contemporary Philistine city was built at Tel Qasile, approximately 10 km to the south of Tel Michal on the bank of the Yarkon River. During the Iron Age II, the settlement at Tel Michal increased in size, and structures of a religious nature were set up on the hillocks to the east of the high tell, alongside limited farming. At that time, Tel Michal was apparently in close contact with the settlements on the Yarkon River, such as Tel Qasile, Tel Gerisa and Tel Kudadi (Gophna & Ayalon, 1989: 21, 27; see also Chap. 4). The period was characterized by a lack of imports, as is also evident at other sites in the region. Evidence exists indicating that during the Iron Age II (9th-8th century BC) a small settlement existed at Apollonia (Roll & Ayalon, 1989: 29). The estuaries of the rivers and wadies along the Sharon were silted up following the general desertion of the coastal towns caused by the invasion of the Sea Peoples. The drainage was not cleared of sand and debris. Therefore boats were beached or put at anchor in the open sea (Raban, 1984: pers. com.), not always a comfortable or safe method for harbouring.

According to Gophna and Ayalon (1989: 21) settlement was renewed at Tel Michal in the Persian period, following a gap of occupation at the end of the Iron Age. Tel Michal was probably a small satellite settlement of Tel Afek and Tel

[1] Not all scientists agree that trade flourished at this time. The minimalistic argument is epitomized by Snodgrass (1991). For Bronze Age trade see Bass (1991: 62-82, especially 73-78) and on maritime commerce in the 13th and 14th centuries see Sherratt and Sherratt (1991).

[2] From various excavations in Israel it may be concluded that there was a general reduction in stability in the region. Dothan (1971: 26) found while excavating at Ashdod that there was a reduction in the level of occupation at the beginning of the Iron Age. Herzog (1989: 142) also found a gap of some 300 years in the occupation of Tel Michal at the beginning of the Iron Age. The excavation of Lachish by Ussishkin (1983: 168) confirms a similar abandonment: "....following the destruction of Level VII in the 12th cent. BC, the city was left in ruins and almost completely deserted for several generations."

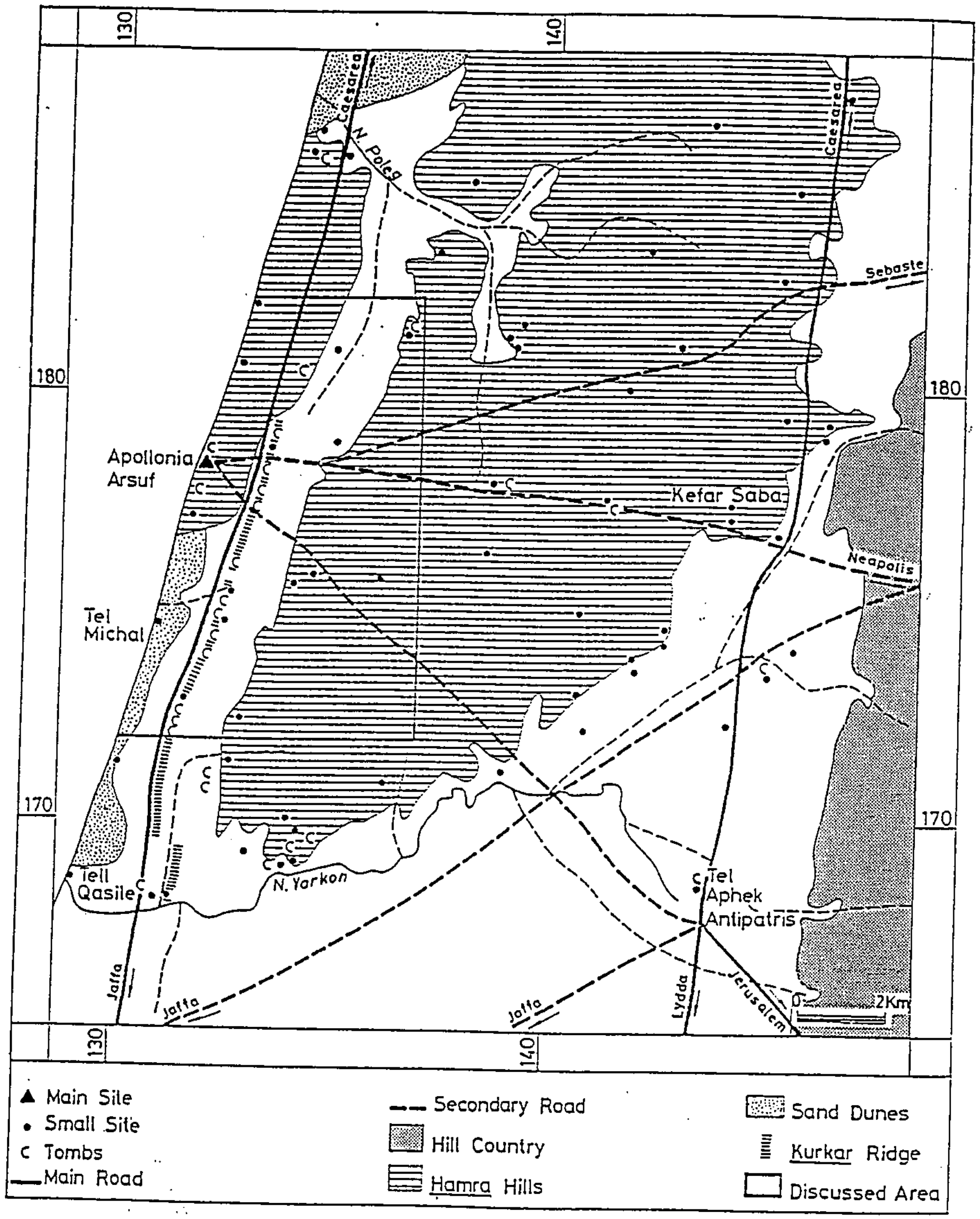


Fig. 14. Roads and sites of the southern Sharon in the Late Roman, Byzantine and Early Arab periods (Herzog, 1989: Fig. 3.5).

Qasila, and was still important mainly as a military and commercial international harbour.

The development of Apollonia, 3.5 km to the north of Tel Michal, slowly suppressed and displaced Tel Michal. The rich finds, such as architectural remains, grave offerings, pottery and Phoenician coins from Sidon and other cities are testimony to the importance of the new settlement (Gophna & Ayalon, 1989: 21-23). Tel Michal and Apollonia co-existed for some time, both apparently under the control of Tyre and Sidon. Agricultural settlements developed on the Sharon Plain, from which a new economic pattern emerged. At this time a settlement called Gelil was founded to the east of Tel Michal, on the second *kurkar* ridge, some 2 km inland. Apollonia was established as an agricultural and industrial settlement and grew in importance through the Byzantine period. "The Persian period marked the beginning of a settlement expansion process that continued - albeit intermittently - in the following periods" (Gophna & Ayalon, 1989: 23).

Apollonia was a small Phoenician settlement during the Persian period (Roll & Ayalon, 1989: 24-34). The finds do not reflect the type and character of the settlement at that time, but it is certain that the inhabitants were dealing and trading in purple-dye, produced from *murex* molluscs. The purple dye trade continued on a larger scale during the Hellenistic period. Rich finds, such as grave offerings, pottery and Phoenician coins from Sidon and other cities, and also large quantities of imported Hellenistic pottery are testimony to the importance of the new settlement. Gophna and Ayalon (1989: 21 & 23) suggested that the Hellenistic authorities intentionally transferred the administrative, military and economic centre from Tel Michal to Apollonia, a relatively new settlement that may have had more advantageous harbour capabilities and better overland routes leading to it.

Apollonia was a Phoenician trade station on the Israeli seashore, facing the sea and not dependent on the agricultural hinterland. There is evidence to indicate that swampy forests were allowed to cover most of the hinterland during this time. The two Phoenician towns of Tyre and Sidon maintained their trading stations along the shore. Apollonia and Jaffa were presumably two of these, possibly belonging to Sidon. These towns along the shore were inhabited during the Persian period not only by Phoenicians, but also by Jews (Roll & Ayalon, 1989: 119-123).

The high tell at Tel Michal was still occupied during the Persian period. A few buildings and a large wine press were excavated to the north of the tell and a settlement was found to the east. A fort was located at the northern end of the high tell and remained in use till the 2nd century BC, when the Hasmoneans controlled the coast (Gophna & Ayalon, 1989: 23). In the Early Roman period, at the start of the 1st century AD, the citadel on the high tell in Tel Michal was used perhaps as a stronghold, to protect the sea and land passages between Apollonia and Jaffa. During the Hellenistic period Tel Michal gradually decreased in importance and size, until its total desertion at the end of the 1st century AD. After its destruction, possibly at the time of the Great Jewish Revolt (1st century AD), Tel Michal was deserted until the Early Arab period in the 8th century AD when it was occupied for a short time (Brandfon, 1989: 195).

As had happened during the earlier periods, small villages began to be established in Apollonia's vicinity rather than around Tel Michal. Following the Hasmonean wars and the decline in Phoenician political influence, the population on the coastal fringe decreased, as is indicated by the absence of significant remains in the large settlements of the Sharon Plain. According to historical documents (Josephus: Jewish Wars I, 172; Plinius. NH V, 13, 69 ed. Mayhoff: 390), Apollonia developed into one of the more important towns along the coast (Roll & Ayalon, 1989: 128). During the Hellenistic period Apollonia did not have an artificially built harbour, and this is implicitly substantiated by Josephus (Jewish Wars I: 409), who says that the reason for the building of a harbour in Caesarea was the lack of a proper harbour between Dor and Jaffa. In the Roman era, Josephus mentions Apollonia as a city, a status which it seems to have inherited from the previous period (Josephus, *Jewish Wars* I. 8,166; cf. Roll & Ayalon, 1989: 50).

At Apollonia, no significant Early Roman artifacts have been found. Some isolated finds in the area of the city and burial caves to the east, as far as Kfar Shmaryahu, were discovered. However, historical evidence for settlement in this period is known (Josephus: *Ant.* xiii 15,4 [395]). A possible reason for the expansion of Apollonia was linked to the Samaritans moving from the hills to the shore in this period, a fact which is documented by archaeological finds (Roll & Ayalon, 1989: 130). The settlement process at Apollonia gained impetus in the 2nd century AD, in the Middle and Late Roman periods, when its agricultural hinterland along the *hamra* hills began flourishing. It reached its peak in the 6th-8th centuries AD. In the Late Roman, Byzantine and Early Arab periods Apollonia was an important port city and its name appeared in historical references (Schuerer, 1979: 114-115).

The nucleus of the town was first situated at the southern end of the site, close to today's path descending to the beach (Fig. 40). At this location, remains of walls and many ribbed pottery sherds are visible along the shore (Roll & Ayalon, 1989: 50). In the 2nd century AD, when most coastal settlements were abandoned (Roll & Ayalon, 1989: 135), Apollonia continued its urban existence. The town grew northwards during the reign of Lucius Septimus Severus (AD 193-211) and prospered (Smallwood, 1976: 487-506). This is also proven by the abundance of imported pottery (such as terra sigillata vessels, amphorae etc.) discovered during excavations. Apollonia is not mentioned in the Mishna and neither in the Talmud, but it is likely that Jews were living among the city's mixed population (Roll & Ayalon, 1989: 51).

Fig. 15. Aerial photograph of Apollonia, 1949, view from the sea to east. On the left of the photograph is the Crusader fortress on the cliff and below it the harbour. The Crusader fortifications encircling the town are clearly visible.

In the Roman period, when Apollonia and its vicinity flourished, a network of roads developed. The main roads from the inland, including roads from Samaria, Nablus, and Jerusalem through Antipatris, led to this town. The international coastal route from Egypt also passed close to the town (Fig. 14). It originated in the Middle Bronze Age and was paved for the first time in the Roman period (Avi-Yonah, 1951: 55). Today's coastal road follows more or less the same course. Slowly Apollonia took over in importance from Antipatris-Aphek and Tel Qasile, both located on the Yarkon River.

During the Byzantine period Apollonia grew rapidly, and expanded to cover an area of some 150 acres which extended approximately 1500 m north to south and 400 m east to west (Roll & Ayalon, 1989: 65). It became a large city with an important manufacturing centre and a developed harbour. The northern sector contained the industrial area where wine, oil and glass were manufactured. The residential area was in the central and southern part of the town. The population was mixed, Christians, Muslims, Samaritans and Jews lived there, although there are no finds which suggest Jewish occupation. A Byzantine church has been excavated. A gravestone and many oil lamps found on the site suggest that Samaritans were among the inhabitants (Roll & Ayalon, 1989: 67). The quantities of Samaritan lamps at the site is impressive, when considering that no evidence of a workshop has yet been found (Sussman, 1983: 71-96).

In the 6^{th}-8^{th} centuries AD numerous settlements existed in the southern Sharon based mainly on agriculture and on the processing of agricultural products, as was shown by the remains of numerous wine and oil presses (Gophna & Ayalon, 1989: 25). Their peak was under the rule of Justinian in the middle of the 6^{th} century AD (Roll & Ayalon, 1989: 178). It is most certain that the prosperity in the 6^{th} to 8^{th} centuries resulted from the preceding Byzantine rule which had brought peace and security to the region. During the Late Roman and Byzantine periods, roads and new agricultural techniques developed and huge efforts were invested in the drainage of fields (an example is the tunnel in Herzlia B) to enable the use of swampland for agriculture. This tunnel (Fig. 13) was excavated through the *kurkar* rock, and is some 175 m long (Roll & Ayalon, 1989: 181).

With all the development and expansion occurring during the Byzantine period, there was a need for a harbour to accommodate the corresponding increase in international trade. A harbour or anchorage is a link for the political, social, economic and certainly geographical fulfillment and needs of the inhabitants (Scoufopoulos *et al*, 1975: 103). Those who directed and governed, had to consider international trade and the needs of the hinterland. This is true for large, as well as small harbours.

There were few changes between the Byzantine and the Early Arab periods; in the 7^{th} century AD, a small part of the town of Apollonia was fortified, probably due to repeated efforts by the Byzantine fleet to reconquer the coastal cities (Roll & Ayalon, 1989: 77-78). In the 8^{th} century AD, as a result of a severe crisis, most of the southern Sharon settlements were abandoned. There was less trade with overseas markets, because of the hostility between the Byzantines and Umayyads and because of the unsafe situation resulting from the attacks by the Byzantines, mainly from the sea. However, inland trade flourished (Roll & Ayalon, 1989: 178-179). The Early Arab period was characterized by a sharp decline at Apollonia (Roll & Ayalon, 1989: 187-191). There could be a number of reasons for this, such as an earthquake or a locust plague, but it would appear that the prime reason was that the centre of the Moslem Abbasid Dynasty was transferred to Baghdad. This caused many small wars and resulted in the neglect of internal security and of agriculture. The religious pressure on the non-Moslem inhabitants caused them to leave and they settled in the fortified towns of the hill country. Apollonia was the only remaining town which still maintained its strong position. It was supported by the rule of the Fatmid. This is documented also by the map drawn by Eli Bahri, an Arab geographer, in the year 1094 which shows a road connecting Apollonia, here called Arsuf, with the Samaria hills (Roll & Ayalon, 1989: 190). The Jewish inhabitants left Arsuf and only Christians remained there. In the course of time many of them converted to Islam[1].

Summarizing the standing of Arsuf in the Early Arab period, the Moslem geographer Muqdassi described it the year 985 as being smaller than Jaffa, fortified and much more densely inhabited. He counted Arsuf among the thirteen important towns of the land in his time and described Arsuf as one of the places where Moslem prisoners of war could be bought back by paying a ransom to the Byzantines (Fahmy, 1966: 55-56; Roll & Ayalon, 1989: 92). It is historically and archaeologically documented that during the Crusader period the settlements towards the inland were slowly being abandoned with their inhabitants moved to the seashore. This happened mainly in the 12^{th} and beginning of the 13^{th} century AD, when most of the Crusaders' settlements were concentrated along the sea shore and the harbour towns were fortified (Prawer, 1952: 22-25; see also Fig. 15). The Crusader period was a time of instability which caused the decline of formerly cultivated land of the Sharon, reverting back to forests and swamps (Roll & Ayalon, 1989: 194). To the north of Apollonia was a large swamp called Lake Catorie (Clement-Gannett, 1903: 201-206). A similar account was given by William of Tyre, in his description of the conquest of Arsuf by the Crusaders in AD 1101 (Willemus Tyrensis, *Chronicon* 10,13 ed. R.B.C. Huygens: 469; Roll & Ayalon, 1989: 194) and in the narrative about the Turks laying in wait for the Crusaders in the forest of Arsuf before the "battle of Arsuf" in September 7-8, 1191 (Archer, 1889:146).

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1 Over the centuries Apollonia changed its name: from Arsuf to Apollonia during the Roman period, in the Byzantine period to Sozousa, the Crusader's called it Arsur and the Arabs again Arsuf. For more details see Roll 1999:8.

The Arab inhabitants of Arsuf held out against the Crusaders with the help of the Egyptian Navy. After King Baldwin I convinced the Genoese merchant fleet, which supported the Franks, to keep the Egyptian Navy at bay, his men captured the city in 1101. In 1187, Saladin captured Arsuf, but after the "Battle of Arsuf" in September 1191, it was re-captured by the Franks (Benvenisti, 1976: 130-131). After the conquest of the town no changes were made to the fortifications. The Crusaders only repaired the existing walls and made some minor changes, so that the town still encompassed an area of 20 acres. This was a large town compared to other Crusader settlements. It is not clear when the fortress in the northern part of the town was built, but it is first mentioned in 1241. The fortress is visible also on the seal of Balian the Old, 1258-1261 (Roll & Ayalon, 1989: 112).

The territory of Arsuf embraced an area of the coastal plain from the Yarkon River in the south to the Poleg River in the north and out to the foothills of Samaria to the east (Roll & Ayalon, 1989: 236). At the end of the 12th century, Arsuf fell into the hands of the Ibelin family. They strengthened the city walls in the year 1240 and in 1261 leased the town to the Crusader Hospitalers, who added new fortifications. Coins found from this period are Crusader, European and also Moslem and, in spite of great hostility, trade between the enemies continued to flourish (Roll & Ayalon, 1989: 114-117).

There can be no doubt that the road along the coast was considered to be most important, as it was one of the links of the Crusaders to Europe. William of Tyre described Baldwin's passage there with his soldiers in 1101, on their way from Caesarea to Jaffa, and later a visit by Richard the Lion-Heart, who passed by the same road, and over a bridge crossing the Yarkon River in the vicinity of Tel Gerisa (Roll & Ayalon, 1989: 194). It is not clear when the Mamelukes conquered Arsuf, but it is known that its destruction was carried out by the Mameluk Sultan Baybars in 1265, to prevent the return of the Christians to the Palestinian shore (Roll & Ayalon, 1989: 114). Later, "during the Mameluk and Ottoman periods, Sidna 'Ali (1 km south from Apollonia) became a military-religious centre and a harbour market for agricultural products" (Gophna & Ayalon, 1989: 27). During the 19th and beginning of the 20th centuries watermelons were grown in the marshland along the Israeli coast. These were exported to Egypt by boats. On the Sharon coast were 11 harbours, including Sidna 'Ali, also called El-Harem, whereto the watermelons were brought by camels and from there transported by small boats to Jaffa, reloaded and sent to Egypt. In 1929 the sea transport was replaced by the railway. The Egyptians imposed taxes on watermelons in 1930 which caused the end of this trade. From 1932 the small harbours along the coast were deserted (Avizur, 1977: 238-245).

CHAPTER 5

ARCHAEOLOGY AND HISTORY AT TEL MICHAL

BY Z. HERZOG

Traditional biblical archaeology focuses on the construction of a 'ladder of progress' of archaeological artifacts and the correlation of unearthed antiquities with written records. This paradigm, that has dominated the archaeology of Israel for decades, led to the preference for digging large 'key sites', well documented in historical sources, such as Megiddo, Jericho, Hazor, Lachish, and many others.

More recent trends in archaeological research, known either as the 'new archaeology', 'anthropological archaeology', or 'social archaeology', focus not only on chronological sequences of objects but also on the cultural and social life of people who produced and utilized these objects, and on social processes which shaped and changed the ancient societies.[1] The excavation of Tel Michal, a small and 'minor' site on the Mediterranean coast, not mentioned in the existing records, fits in well with this new direction in archaeology. This site was viewed not as an end in itself, but as a means for studying cultural adaptation and changes in the central coastal plain. The geographical setting of Tel Michal in the Sharon plain, a marginal zone of human occupation, made it even more attractive for the study of cultural adaptation, since in such regions even minor environmental fluctuations or socio-economic developments play a significant role (Baly, 1961: 79-85). The frequent gaps in the history of Tel Michal, in contrast to the temporal continuity of major cities, illustrate the sensitive subsistence conditions.

Four seasons of large-scale excavations at Tel Michal by a multinational and multidisciplinary expedition[2] demonstrate how much information could be 'extracted' from a minor site, when proper methodology is applied and the evidence is presented and synthesized in a final report (Herzog, Rapp, Negbi, 1989).

In more general terms, Tel Michal illustrates a quest for the history of a Mediterranean site about which our information is only archaeological. The combination of new approaches in archaeology with the historical question, which perforce addresses itself to archaeology, may yield a new perspective on 'Mediterranean cities'. A 'new history' of both this particular site and of the coastal plain in general seems to emerge for the Bronze and Iron Ages, as well as for the Persian, Hellenistic, Roman and Early Arab periods. The present summary aims to emphasize the main conclusions of the project.

5.1 Environmental conditions

Tel Michal is located on a *kurkar* (sandstone) cliff overlooking the Mediterranean about 6.5 km north of the Yarkon River estuary, in the southern part of the Sharon coastal plain (Fig. 1). This region is divided into a number of parallel longitudinal strips (Karmon, 1961: 43-60). In the west are three *kurkar* ridges separated by low-lying troughs *(marzeva)*, which filled up in winter to create swamps and stagnant pools. The third (eastern) *kurkar* ridge is covered extensively by thick layers of sandy red soil (*hamra*), which extend to the east, and form the *hamra* hills of the Sharon (about 10 km wide). These hills were covered in pre-modern times by an oak forest (*Quercus calliprinos*). There was a wide fertile valley east of the hill, but this area was too far from Tel Michal to be cultivated.

The soils in the troughs near Tel Michal were too sandy and salty for the dry farming of cereals, but were suitable for viticulture. Numerous wine-presses, dating from the Late Bronze Age to the Byzantine period, were uncovered throughout the southern Sharon.[3] However, the production of wine alone could not justify occupation of the site, or alternatively explain the frequent gaps. Other natural resources like fish or game provided less than 10 per cent of the animal bones found. Although the bones of sheep, goats, and cattle comprise over 90 per cent of the osteological assemblage, this does not necessarily indicate local animal husbandry. The numerical predominance of bones belonging to the forepart of the skeleton indicates that the animals

[1] The main contributors to this paradigmatic change are Lewis R. Binford in the US and Colin Renfrew in England. See L.R. Binford, *In Pursuit of the Past: Decoding the Archaeological Record* (New York, 1983); C. Renfrew, *Approaches to Social Archaeology* (Edinburgh, 1984). For a general introduction, see G. Gibbon, *Anthropological Archaeology* (New York, 1984).

[2] Participating institutions and core-staff included the following: James D. Muhly, Project Director University of Pennsylvania; Ze'ev Herzog, Archaeological Field Director, Tel Aviv University (hereafter TAU); George Rapp, Jr., Archaeometry Director, University of Minnesota; Anson F. Rainey, Educational Director, TAU; Ora Negbi, Find Processing Co-ordinator, TAU; Frederic R. Brandfon. Project Co-ordinator, University of Pennsylvania; Geoffrey Cowling, Macquarie University, Australia; John Lawrenz, Wisconsin Lutheran Seminary; LeGrande Davies, Brigham Young University.

[3] On the Late Bronze winepress at Afek, see M Kochavi, 'The History and Archaeology of Afek-Antipatris', *Biblical Archaeologist,* 44 (1981), 80-81. Winepress from the Iron Age up to and including the Hasmonean period were found at Tel Michal, and for later periods see Roll and Ayalon, 'Two Large Wine Presses in the Red Soil Regions of Israel', *PEQ*, 113 (1981), 111-125.

The Arab inhabitants of Arsuf held out against the Crusaders with the help of the Egyptian Navy. After King Baldwin I convinced the Genoese merchant fleet, which supported the Franks, to keep the Egyptian Navy at bay, his men captured the city in 1101. In 1187, Saladin captured Arsuf, but after the "Battle of Arsuf" in September 1191, it was re-captured by the Franks (Benvenisti, 1976: 130-131). After the conquest of the town no changes were made to the fortifications. The Crusaders only repaired the existing walls and made some minor changes, so that the town still encompassed an area of 20 acres. This was a large town compared to other Crusader settlements. It is not clear when the fortress in the northern part of the town was built, but it is first mentioned in 1241. The fortress is visible also on the seal of Balian the Old, 1258-1261 (Roll & Ayalon, 1989: 112).

The territory of Arsuf embraced an area of the coastal plain from the Yarkon River in the south to the Poleg River in the north and out to the foothills of Samaria to the east (Roll & Ayalon, 1989: 236). At the end of the 12th century, Arsuf fell into the hands of the Ibelin family. They strengthened the city walls in the year 1240 and in 1261 leased the town to the Crusader Hospitalers, who added new fortifications. Coins found from this period are Crusader, European and also Moslem and, in spite of great hostility, trade between the enemies continued to flourish (Roll & Ayalon, 1989: 114-117).

There can be no doubt that the road along the coast was considered to be most important, as it was one of the links of the Crusaders to Europe. William of Tyre described Baldwin's passage there with his soldiers in 1101, on their way from Caesarea to Jaffa, and later a visit by Richard the Lion-Heart, who passed by the same road, and over a bridge crossing the Yarkon River in the vicinity of Tel Gerisa (Roll & Ayalon, 1989: 194). It is not clear when the Mamelukes conquered Arsuf, but it is known that its destruction was carried out by the Mameluk Sultan Baybars in 1265, to prevent the return of the Christians to the Palestinian shore (Roll & Ayalon, 1989: 114). Later, "during the Mameluk and Ottoman periods, Sidna 'Ali (1 km south from Apollonia) became a military-religious centre and a harbour market for agricultural products" (Gophna & Ayalon, 1989: 27). During the 19th and beginning of the 20th centuries watermelons were grown in the marshland along the Israeli coast. These were exported to Egypt by boats. On the Sharon coast were 11 harbours, including Sidna 'Ali, also called El-Harem, whereto the watermelons were brought by camels and from there transported by small boats to Jaffa, reloaded and sent to Egypt. In 1929 the sea transport was replaced by the railway. The Egyptians imposed taxes on watermelons in 1930 which caused the end of this trade. From 1932 the small harbours along the coast were deserted (Avizur, 1977: 238-245).

Chapter 5

Archaeology and History at Tel Michal

by Z. Herzog

Traditional biblical archaeology focuses on the construction of a 'ladder of progress' of archaeological artifacts and the correlation of unearthed antiquities with written records. This paradigm, that has dominated the archaeology of Israel for decades, led to the preference for digging large 'key sites', well documented in historical sources, such as Megiddo, Jericho, Hazor, Lachish, and many others.

More recent trends in archaeological research, known either as the 'new archaeology', 'anthropological archaeology', or 'social archaeology', focus not only on chronological sequences of objects but also on the cultural and social life of people who produced and utilized these objects, and on social processes which shaped and changed the ancient societies.[1] The excavation of Tel Michal, a small and 'minor' site on the Mediterranean coast, not mentioned in the existing records, fits in well with this new direction in archaeology. This site was viewed not as an end in itself, but as a means for studying cultural adaptation and changes in the central coastal plain. The geographical setting of Tel Michal in the Sharon plain, a marginal zone of human occupation, made it even more attractive for the study of cultural adaptation, since in such regions even minor environmental fluctuations or socio-economic developments play a significant role (Baly, 1961: 79-85). The frequent gaps in the history of Tel Michal, in contrast to the temporal continuity of major cities, illustrate the sensitive subsistence conditions.

Four seasons of large-scale excavations at Tel Michal by a multinational and multidisciplinary expedition[2] demonstrate how much information could be 'extracted' from a minor site, when proper methodology is applied and the evidence is presented and synthesized in a final report (Herzog, Rapp, Negbi, 1989).

In more general terms, Tel Michal illustrates a quest for the history of a Mediterranean site about which our information is only archaeological. The combination of new approaches in archaeology with the historical question, which perforce addresses itself to archaeology, may yield a new perspective on 'Mediterranean cities'. A 'new history' of both this particular site and of the coastal plain in general seems to emerge for the Bronze and Iron Ages, as well as for the Persian, Hellenistic, Roman and Early Arab periods. The present summary aims to emphasize the main conclusions of the project.

5.1 Environmental conditions

Tel Michal is located on a *kurkar* (sandstone) cliff overlooking the Mediterranean about 6.5 km north of the Yarkon River estuary, in the southern part of the Sharon coastal plain (Fig. 1). This region is divided into a number of parallel longitudinal strips (Karmon, 1961: 43-60). In the west are three *kurkar* ridges separated by low-lying troughs *(marzeva)*, which filled up in winter to create swamps and stagnant pools. The third (eastern) *kurkar* ridge is covered extensively by thick layers of sandy red soil (*hamra*), which extend to the east, and form the *hamra* hills of the Sharon (about 10 km wide). These hills were covered in pre-modern times by an oak forest (*Quercus calliprinos*). There was a wide fertile valley east of the hill, but this area was too far from Tel Michal to be cultivated.

The soils in the troughs near Tel Michal were too sandy and salty for the dry farming of cereals, but were suitable for viticulture. Numerous wine-presses, dating from the Late Bronze Age to the Byzantine period, were uncovered throughout the southern Sharon.[3] However, the production of wine alone could not justify occupation of the site, or alternatively explain the frequent gaps. Other natural resources like fish or game provided less than 10 per cent of the animal bones found. Although the bones of sheep, goats, and cattle comprise over 90 per cent of the osteological assemblage, this does not necessarily indicate local animal husbandry. The numerical predominance of bones belonging to the forepart of the skeleton indicates that the animals

[1] The main contributors to this paradigmatic change are Lewis R. Binford in the US and Colin Renfrew in England. See L.R. Binford, *In Pursuit of the Past: Decoding the Archaeological Record* (New York, 1983); C. Renfrew, *Approaches to Social Archaeology* (Edinburgh, 1984). For a general introduction, see G. Gibbon, *Anthropological Archaeology* (New York, 1984).

[2] Participating institutions and core-staff included the following: James D. Muhly, Project Director University of Pennsylvania; Ze'ev Herzog, Archaeological Field Director, Tel Aviv University (hereafter TAU); George Rapp, Jr., Archaeometry Director, University of Minnesota; Anson F. Rainey, Educational Director, TAU; Ora Negbi, Find Processing Co-ordinator, TAU; Frederic R. Brandfon. Project Co-ordinator, University of Pennsylvania; Geoffrey Cowling, Macquarie University, Australia; John Lawrenz, Wisconsin Lutheran Seminary; LeGrande Davies, Brigham Young University.

[3] On the Late Bronze winepress at Afek, see M Kochavi, 'The History and Archaeology of Afek-Antipatris', *Biblical Archaeologist*, 44 (1981), 80-81. Winepress from the Iron Age up to and including the Hasmonean period were found at Tel Michal, and for later periods see Roll and Ayalon, 'Two Large Wine Presses in the Red Soil Regions of Israel', *PEQ*, 113 (1981), 111-125 .

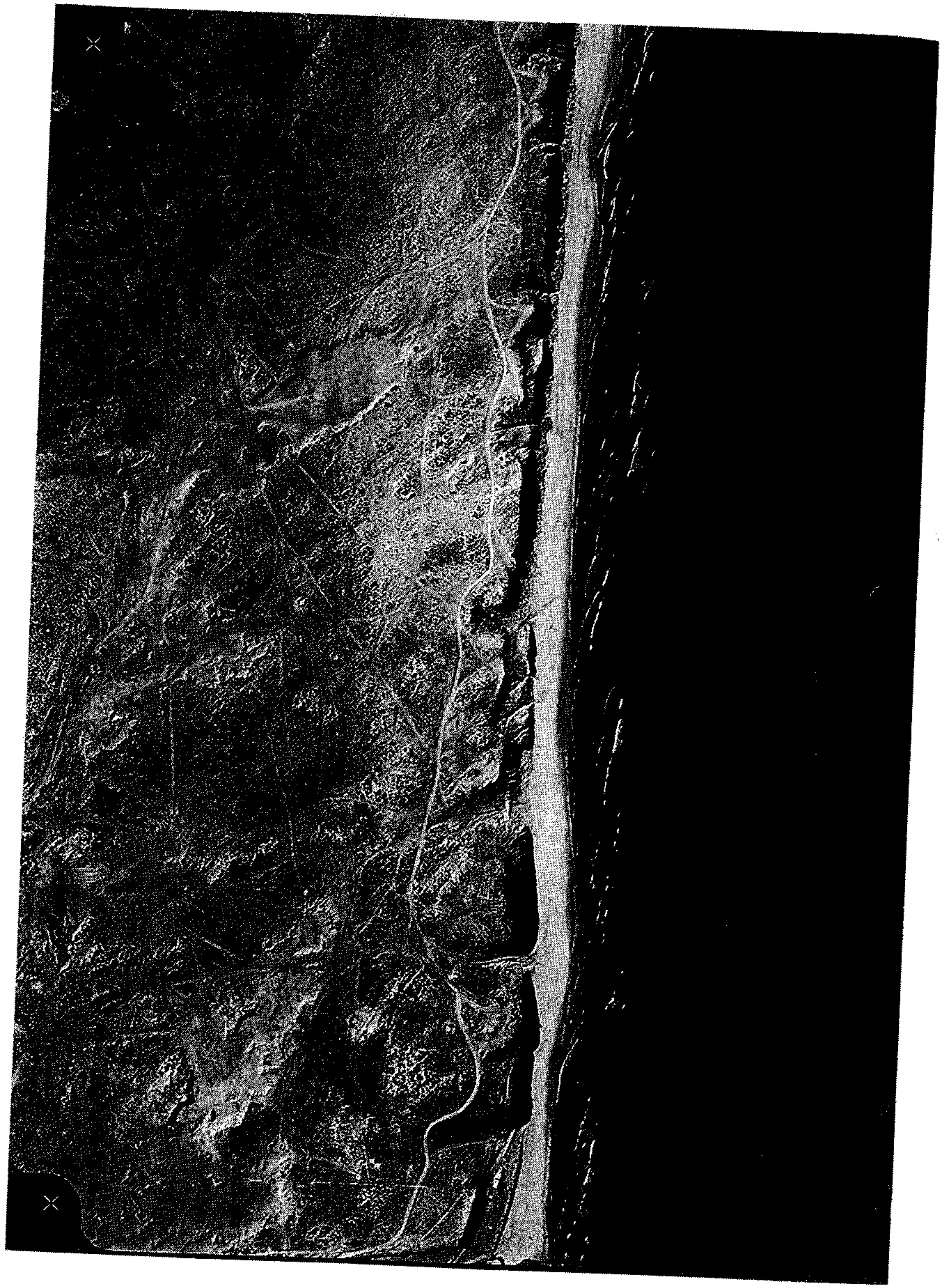

Fig. 16. Aerial view of Tel Michal. View to east.

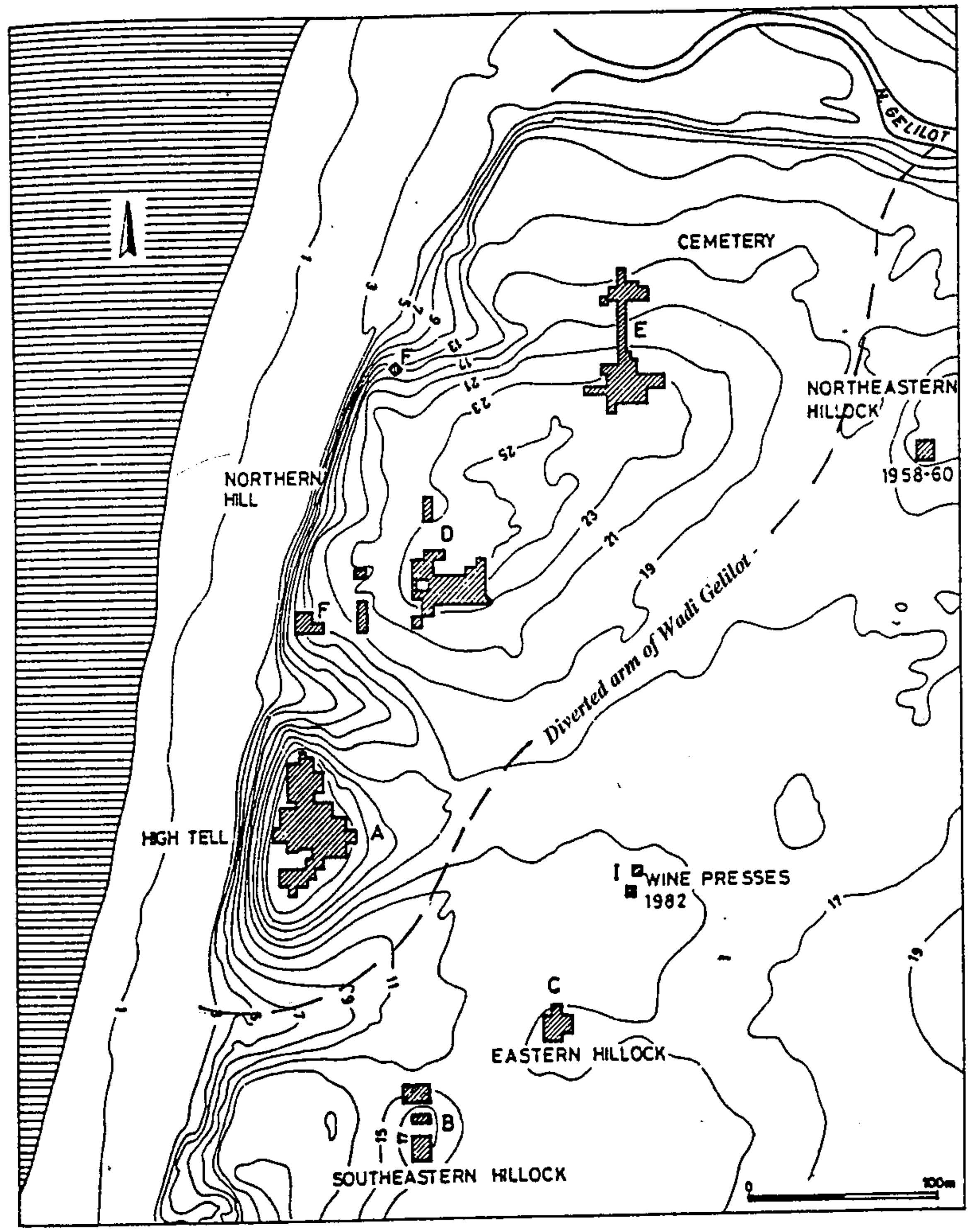

Fig. 17. Topography and excavation areas at Tel Michal.

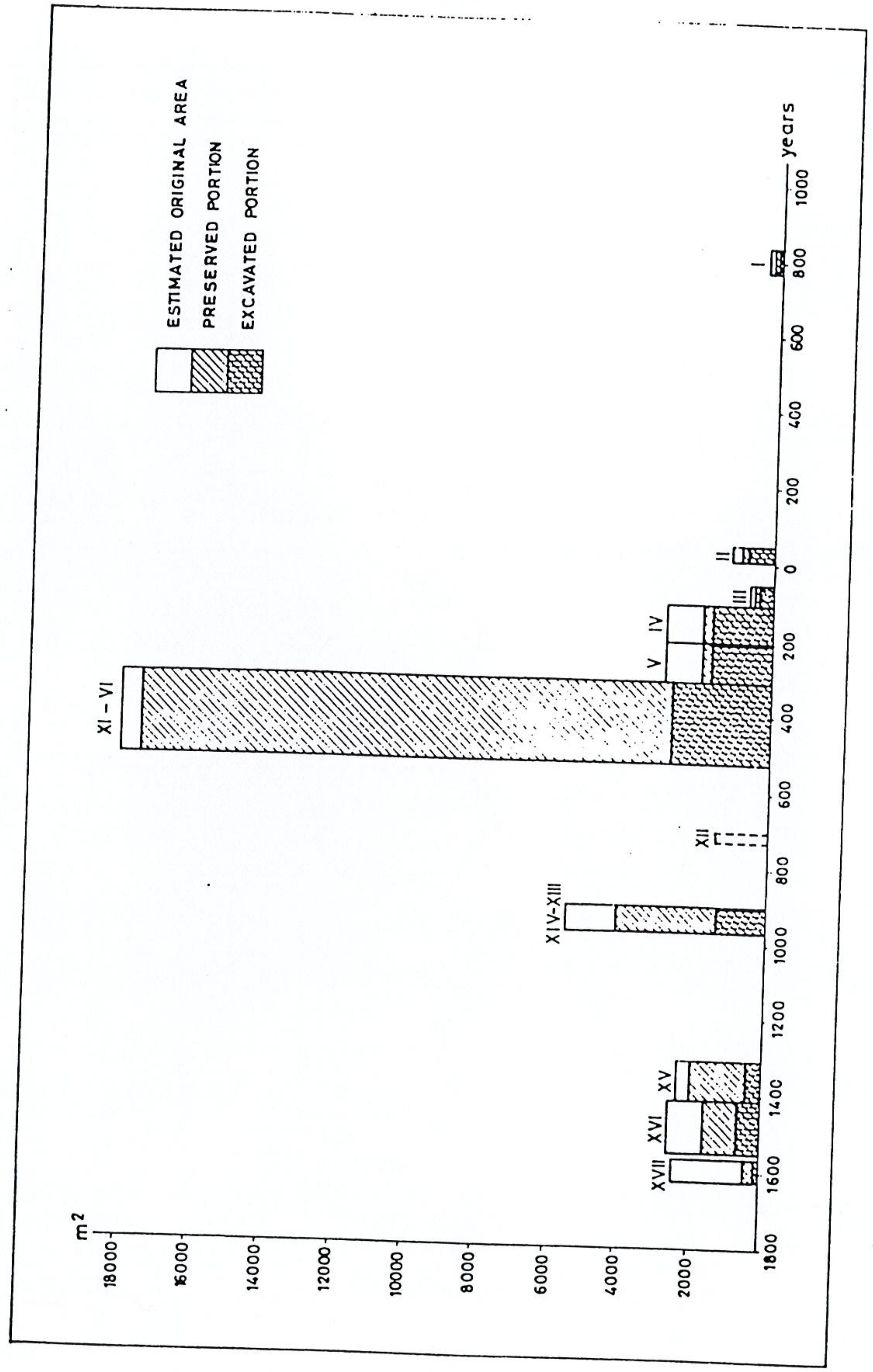

Fig. 18. Occupational periods, gaps, and relative sizes of the settlements at Tel Michal. Each column represents the (estimated) total size of the settlement, its preserved portion, and the excavated portion.

were slaughtered elsewhere and then distributed (Hellwing and Feig, 1989: 236-247).

The archaeological data show a clear correlation between the periods of occupation and phases of maritime activity; combined with its location, they corroborate the site's *raison d'etre* as a coastal trading station.

Such an interpretation must be supported by the presence of a harbour at the site. Today, no natural bay or visible remains of anchorage facilities exist. However, in aerial photographs taken when the sea was calm, remnants of an abraded *kurkar* ridge was clearly visible in the shallow waters of the surf zone parallel to the coastal cliff (Fig. 16). Immediately below the tell, the crescent-shape rock is much wider than the strips to its north and south. An underwater survey conducted by the team from the Centre for Maritime Studies of Haifa University recorded a channel about 30-40 m wide and up to 2 m deep between the eroded ridge and the beach. This channel may have afforded safe anchorage, the *kurkar* ridge on the seaward side (less abraded) serving as a breakwater. The logical place for the entrance into the channel would have been from the north, near the estuary of Nahal Gelilot, where there is a gap in the underwater ridge. Although it is possible that light vessels were pulled up onto the beach (like the fishing boats of today), evidently the first settlers chose this particular spot because of the suitable and safe facilities for anchoring their small craft.

Tel Michal is also unusual in its shape. Unlike the single mounds characteristic of most tells in Israel, the debris of ancient remains were spread over five separate locations (Fig. 17): the high tell (only 0.3 ha) rising to 30 m above sea level, the northern hill, about 4 ha in area, and slightly lower in elevation, and three small hillocks a few hundred metres to the east. A method of wide horizontal exposure resulted in extensive parts of the site being excavated, except for the northern hill which was in a poor state of preservation. Figure 18 presents the history of occupation at the site, its assumed original size, and the preserved and excavated areas.

Before the first occupation of Tel Michal in the Middle Bronze IIB period, the area was occasionally visited by prehistoric communities of hunters and gatherers during the Epipalaeolithic and Pre-Pottery Neolithic B periods. During the Pottery Neolithic, Chalcolithic and Early Bronze I periods, seasonal settlements of hunters, occupied in sporadic agriculture, are found adjacent to small winter swamps. The inadequacy of the area for permanent agricultural settlement is further demonstrated in the Early Bronze Age, when villages and cities developed at Tel Gerisha, Tel Qana and Afek - all along the Yarkon Valley - while around Tel Michal the area was still used solely for grazing and hunting (Gophna & Ayalon, 1989: 12-28).

5.2 The Bronze Age (Strata XVII-XV)

The first settlement at Tel Michal was erected on the high tell in the Middle Bronze IIB period (Stratum XVII) in the late seventeenth century BC. This was a small site of about 50 m square, constructed on an artificial *hamra* platform. It was 4 m high and surrounded by earthen ramparts made of sand fill and capped by packed *hamra* soil; two fragments of its defensive wall were preserved. The platform was only wide enough for a few houses, and most of the original mound collapsed onto the beach, destroyed either by sea abrasion or, more likely, by earthquake.[4] The analysis of settlement patterns in the coastal plain reveals that Tel Michal is the northernmost coastal site first erected in the MBIIB period. The impetus for settlement in the north during the earlier phase, MBIIA, is generally considered to have originated from the Syro-Lebanese coast. But what is the historical background to developments in the southern coastal plain? The answer to this question involves establishing the precise date for the earliest pottery assemblage which belongs to the latter stage of the Middle Bronze Age IIB. This date is contemporary with the Fifteenth (Hyksos) Dynasty that ruled over Lower Egypt and the southern coastal plain of Canaan in the late seventeenth and early sixteenth centuries BC.[5] To define the date even further, I would suggest a correlation with Apophis I, as proposed by Dothan for the founding of Tel Mor and Tel Ashdod, which resemble Tel Michal in many aspects (Dothan, 1973: 1-17). Tel Michal would then have been the northernmost station among the newly established sites during this flourishing phase of the Fifteenth Dynasty, and may have marked the northern limit of direct Hyksos suzerainty in the coastal plain in the Middle Bronze Age IIB.

The absence of fortifications at our site supports the assumption of peaceful and prosperous conditions in the region at this time, undoubtedly related to intensified trade in the Eastern Mediterranean. Archaeologically, this commerce is represented by an abundance of Cypriot imports found at various sites along the coast. Historical evidence comes from the second stela of Kamose, which mentions hundreds of cedar ships, owned by the Hyksos ruler Apophis I, that carried merchandise from *Rtnw* (Habachi, 1972: 37).

Evidence of maritime trade, together with the non-military character of the newly founded settlements, indicate that the stimulus for the wave of settlement on the southern coast of Canaan did not come from any threat of an Egyptian attack, as suggested by Dothan, but quite the opposite; the prevailing peace and prosperity created by flourishing

[4] For the earthquake theory, based on an interpretation of the change in orientation of the defensive wall at Tel Michal, see Z. Herzog and A. Horowitz, 'Archaeological Evidence on Possible Tectonic Rotation and Partial Destruction of Tel Michal', *Abstracts of Tel Aviv Conference of the Israel Geographical Association* (December, 1986), 22 (Hebrew).

[5] For a general discussion see A. Kempinski, *Canaan (Syria-Palestine) during the Late Stage of the MBIIB (1650-1550 B.C.)*' Ph.D. dissertation, Hebrew University, Jerusalem, 1974, 126-32 (Hebrew).

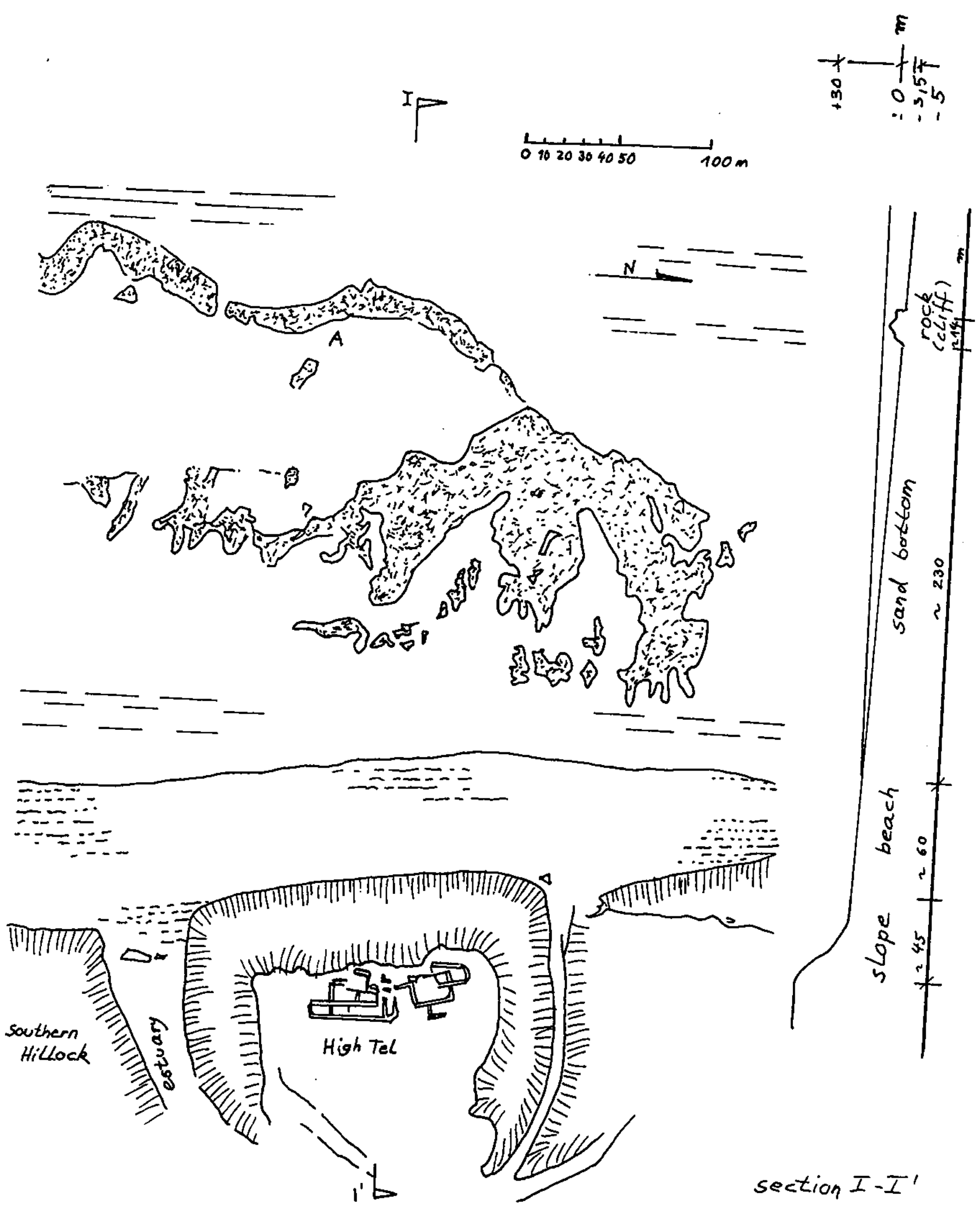

Fig. 21. Map of Tel Michal based on an aerial photohraph and survey.

CHAPTER 6

MARITIME TEL MICHAL

6.1 Background

The land excavations, together with our knowledge of the significance of trade, transport and politics of the region, provide a clear indication of the importance of Tel Michal. It seems probable that throughout most of its life-time, the town served as a maritime station, catering to military and commercial interests. Tel Michal was utilized in international trade and provided services to ships and seafarers. The archaeological finds made in the land excavations show a clear correlation between the periods when trade contacts along the eastern Mediterranean coast were developed, and the extent of occupation at Tel Michal (Herzog, 1989: 8).

The location of the Tel Michal harbour has been a mystery eluding researchers for some time. It is obvious that the city would have needed a reasonably reliable port. Clearly establishing where this port was located would complete the important historical picture. International trade with Tel Michal may be traced back to the Middle Bronze IIB period. From the Iron Age, as on other sites in Israel, there is a clear lack of imports. Eventually, during the Persian period, finds of imported items at Tel Michal become abundant. From the Hellenistic period the principal type of ceramic wares found are locally produced with a few imported articles.

6.2 Site investigation

The objective of this research was to determine the whereabouts of the harbour-anchorage at Tel Michal and to establish how and where merchant ships of antiquity moored, allowing for the loading and unloading of goods.

Obtaining archaeological data from Tel Michal had to be done expeditiously, as major construction was being carried out in the vicinity. A modern yacht harbour and land structures were being built by the Herzlia Municipality adjacent to the site and were partially completed by 1994. The latter complex is located in the gap between the southern site of the high tell and the southern hillock. As this area and the inshore waters were to be significantly disrupted, it was decided to investigate them as a first priority. Aerial photographs were obtained from the Survey of Israel. We also attempted to obtain satellite photographs, to pinpoint the ancient flow of the Nahal Gelilot or River, but the German firm who made them was unable to provide them because of the military installations located nearby.

Physical assistance, essential to underwater investigations, was provided by volunteers, mostly former commandos of the Israeli Navy. We commenced a survey of the inshore waters with a photographic study. Photographs taken on this excursion from the high tell were compared with an aerial photograph (Fig. 16 & 21), to obtain as complete an understanding as possible of the submerged topography. The formation of submerged rocks forming a reef was clearly visible, when standing on top of the high tell, as well as in the aerial photograph[1]. A photo mosaic could not be produced because strong shifting of sands caused part of the site always to be concealed.

The optimum period for underwater work is during the autumn months of September-October (although this project was prolonged until December) and in the spring months of March-April when the sea is mostly calm. In summer, rough seas prevent regular underwater work. The shallow depth, at which the fieldwork was undertaken, allowed for long uninterrupted diving spells. Underwater sessions, however, had to be restricted to periods of approximately one hour and a half, because of the physiological effects of prolonged immersion in open water; in December, the water temperature drops to about 15 degrees Celsius.

Diving and conducting underwater research encountered unexpected obstacles at Tel Michal, caused primarily by the strong longshore current, a pattern of widely variable and rapidly changing water conditions, particularly water clarity, and dramatic daily shifts in near-shore sand deposition (see Chapt. 2). We were also confronted with the familiar problems, when working and organizing underwater work, such as weightlessness of the diver, poor visibility, low temperatures, problems of communication between the divers underwater and with the team on shore, and many others.

Important for us were the findings of the team from the Centre of Maritime Studies, Haifa University, who performed two measurements of the submerged sites immediately to the north of the crescent-shaped offshore reef, in which we were interested. One was on a rock outcrop and the other further to the north at the continuation of where today's road, built in the bed of Wadi Nahal Gelilot, runs. It was established that the water-bed of the wadi was also in ancient times located in the same channel.

[1] On the usefulness of aerial photography for "a well-defined site in shallow water" see Green, 1990: 40.

Gifford *et al.*, (1989: 209 ff, Fig. 18.1) explored sections of the seashore by drilling an array of jet-hole probes. At one of these (hole 4 southernmost: transect Z-Z') at the southwestern foot of Tel Michal ".... the probe bottomed at 4 m still in the dark gray sand which here was a black organic (?) fraction with a faint hydrogen sulfide odor. A 2m extension rod was added and another probe was made near the same locality. The dark gray sandy gravel was found to extend to 6 m below the surface at which depth reddish yellow silty sand was encountered, either *hamra* or friable *kurkar*" (Quoting Gifford; see Fig. 22).

These finds indicate that a body of water used to exist at the southern side of the high tell. It is likely that during the Bronze Age some of the waters of Nahal Gelilot were diverted to flow behind the tell to maintain a clear channel for shipping. This is in line with the theory that the harbour was an estuary-harbour in a channel to the southeast of Tel Michal.

The work at Tel Michal provided an opportunity for methodological experimentation which proved invaluable for the later work at Apollonia. Techniques were continually improved. Resources were limited, so improvisation was common. A movable sub-surface grid system was tested at Tel Michal and served as the basis for detailed mapping at Apollonia. The grid unit was an adaptable system which could cover an area of up to 30 x 30 m and which could be altered in size to meet varying conditions. The grid was anchored using 5 kg concrete cubes with embedded 1 m long iron rods to which improvised buoys were attached (plastic bottles stuffed with white paper to enhance visibility). White nylon ropes, forming the squares of the grid along both its axes, were marked at 2 m intervals with differently-coloured insulating tape and kept in place on the sea bottom by 25 cm long 6 mm diameter iron pegs, hooped at the top to hold the nylon line; to each of them was tied a length of line with a red cork at its end as a floating marker.

Readings were taken and recorded underwater by two to three team members, ideally two with SCUBA and one with mask and snorkel who communicated the readings to shore, where the distance permitted, orally or otherwise by hand signals. This simultaneous recording obviated mistakes. The differently coloured insulation-tape markers along the two axes of the grid simplified underwater handling during poor visibility and enabled us to use partial grids only (two longitudinal nylon ropes and only one cross rope). This also avoided possible tangling of diving equipment in an overly cluttered grid system. Underwater photographs were taken with a Nikonos IV camera with strobe flashlight 103 and a Sea & Sea Automarine II camera. The team used an inflatable Zodiac Mark V workboat, powered by a 50 HP Mercury engine.

A solid point was selected to serve as the permanent zero water-level reference. This avoided confusion due to the effects of atmospheric sea level changes and of tides which are usually at this season 20-30 cm (Fishelson, 1978: 38) and ensured reference to the same basic water levels at Tel Michal and Apollonia. This zero reference point was established at Apollonia, on the northern pier of the "Crusader harbour".

A detailed survey of the inshore waters was conducted employing a rubber boat. A diver was slowly towed over the site, the boat steering systematically back and forth along a serpentine course in order to identify any object possibly relevant to our investigation. The next step involved conducting a survey of the sea bed. We decided to dive as often as sea conditions permitted. We continued to look for any archaeological artifacts or feature that could be found and also paid close attention to the sand movements. Because of the shallow water, we could dive only when the water was calm, as it was dangerous to be exposed to the surge of the sea. As the underwater site is not very distant from the seashore, it was always possible to reach it by swimming with or without diving tanks. This meant slower progress, but we overcame it by diving more often, sometimes several times a day. Even when the sea was calm, visibility could still be very poor. We could swim over the reef at Tel Michal and scarcely recognize it. When passing it on the western side, visibility could instantly become perfect. On other occasions the sea became progressively rougher and it was difficult to return to the shore with all our equipment. On these occasions we were unable to execute any useful task. Frequently the sea was swarming with plankton and other microscopic life which hung over the sea-bed like clouds or fog. Sometimes when plankton was not too dense, it was possible to encounter reasonable visibility. However, photography was extremely difficult, as the suspended matter caused mirror-like reflections.

The diving expeditions confirmed that the reef forms a crescent shape, adjoining the sea-shore at the northern end and continuing to the southwest, to a point about 200 m west from the sea-shore just opposite the high tell (Figs. 16 & 21). The rock reef then turns to the south, forming a crescent shape some 400 m long. At its southern end the crescent eventually disappears under a layer of sand. Some 40 m further to the south, the rocks re-emerge and continue parallel to the seashore. The crescent creates a natural breakwater. A navigable passage of approximately 30-40 m width is clearly visible through a gap at the southern part of the crescent. Boats could be beached or enter the possible harbour on the southern and eastern sides of the high tell, to be tied alongside a quay if such existed. The basin formed on the lee of the crescent, to the east of the submerged rock formations, was covered with a thick layer of sand. To the west of the crescent the sea bed is also sandy. Approximately 500 m further to the west is another reef running nearly parallel to the seashore. This second reef lies some 6 m underwater, too deep to have obstructed ancient seafaring.

The rock crescent was surveyed starting from its northern end where it reaches the beach, to its southern point, where it disappears under the sand. The top of the crescent was

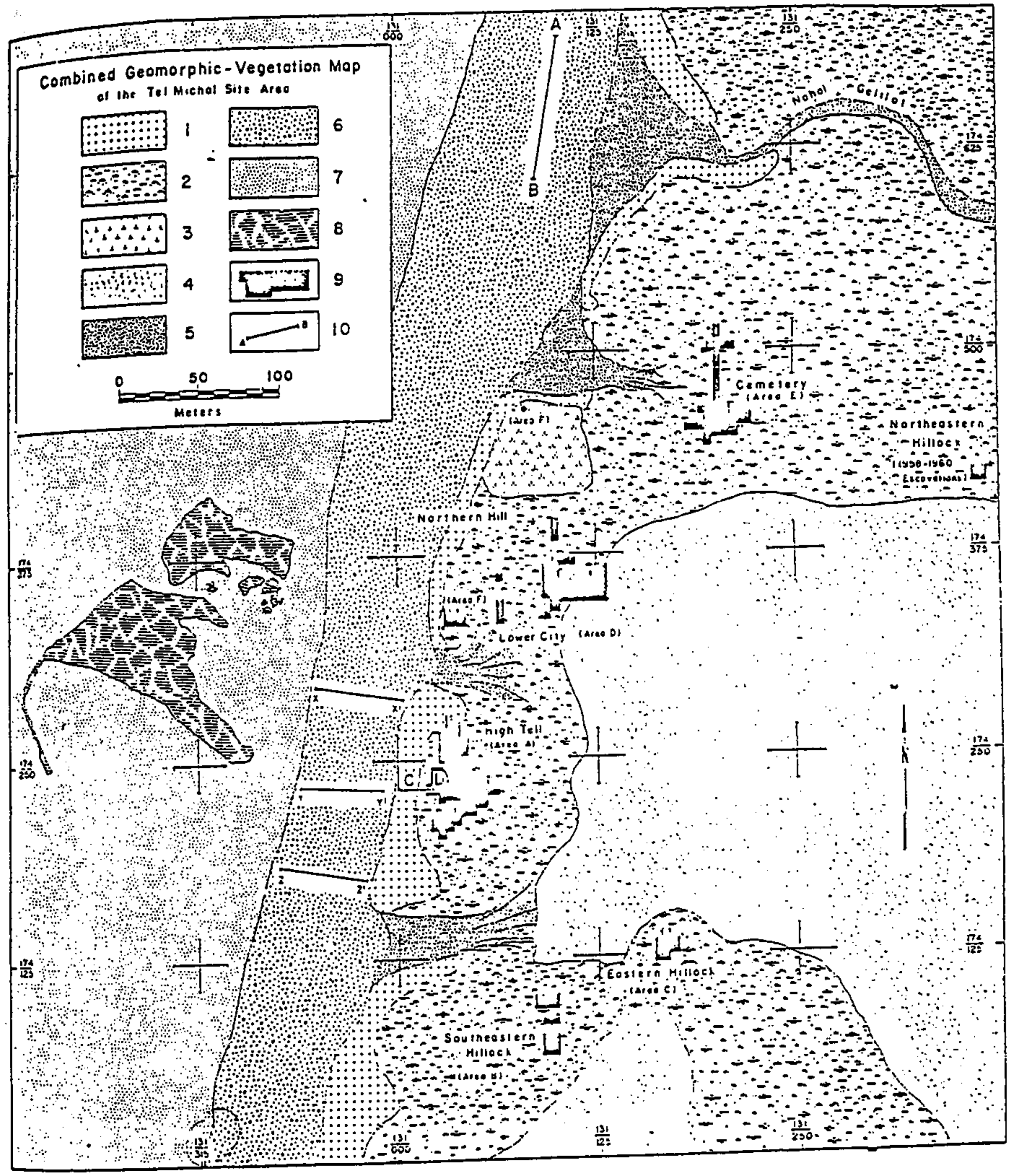

Fig. 22. A geomorphological and vegetational map of Tel Michal, based on aerial photography and a field survey during the excavation periods 1977-1980, and three transects made perpendicular to the cliff face of the high tell (X-X', Y-Y' and Z-Z' the southernmost). (Herzog, 1989: 211)
The transect mentioned in this chapter (6.2) is marked on this map.

found to be some 0.5-1.0 m below water level, along its entire length. Some 15 m from its southern end, the rocks descend gradually and disappear under the sand cover. Opposite the high tell, on a line perpendicular to the line of the beach, we discovered four large ashlar blocks. These measured approximately 1.25x0.4x0.4 m. They are scattered on the eastern side of the crescent (inside). We also found at the same location a few broken pieces of the same kind of stones. There was also a number of different stones, almost round in section measuring on the short axis some 30 cm and about 50 cm in length; the stones were not uniform in size, but looked very similar to each other. Heavy encrustation on these stones made precise measurements impossible. All these stones were positioned upright. It is believed that these were also ashlar stones that eroded with time, being exposed to the violent action of the waves and the ever-moving sands (Fig. 23). Between those stones we found one small sherd of an LB cooking pot and a fragment of a bowl (Chapt. 9, Figs. 60.6 & 7).

6.3 Discussion

Archaeological evidence suggests that Tel Michal must have been serviced by a harbour or anchorage of some sort. This could have been facilitated in at least three possible ways. First, there may have been an inshore harbour-anchorage protected by the natural breakwater to the west. Second, vessels could have been simply beached directly onto the shore. We also considered a third explanation, the existence of an artificial "estuary-channel" to the south and east of the high tell, a feature associated with the building of three artificial fill-platforms on the high tell (Fig. 19).

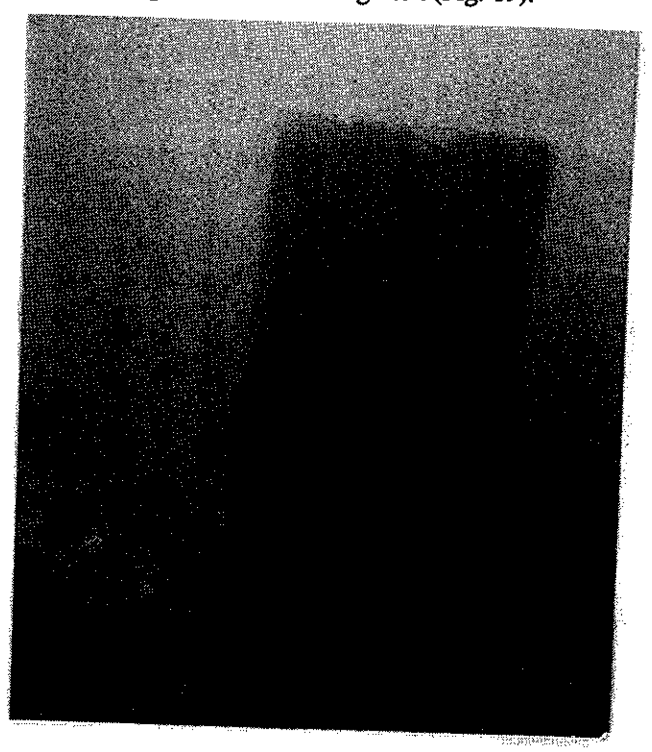

Fig. 23. Standing column under water.

The first possibility that a harbour was built in the sea using the natural rock crescent near the shore as its foundation was suggested by Prof. Z. Herzog, director of Tel Michal land excavations. He considered the possibility of a harbour constructed with a pier and facilities for loading and unloading ships, as well as the existence of storage facilities. If this hypothesis was correct, Tel Michal would be the oldest known instance of building a pier into the sea. The earliest known proven example is a Phoenician structure on the Syrian coast at Tabat el Hamman (Frost, 1972: 95-114).

Our research disproves the alternative of a harbour in the sea. No structural remains have been found in the sea, on or around the inshore crescent or on the shore, except for an isolated group of ashlar stones at the southern tip of the crescent. Hence, no evidence was found supporting the concept of a sea-side harbour at Tel Michal.

The second possibility is that ships were beached directly onto the shore where cargoes were loaded and unloaded. Considering this option, Prof. A. Raban from Haifa University examined the Tel Michal site and concluded that it was likely that ships were indeed beached on the sandy shore, and after rapid unloading and reloading were again launched (Raban, 1979).

The beaching of ships on sandy shores was practiced widely in antiquity. It is described by Homer in the *Iliad* (Book II. lines 151-154). However it is unlikely that merchant vessels were often beached, as they were propelled by sails and to make the trip economically worthwhile, carried a minimum of sailors. Beaching would have required labour both for the towing of a vessel to shore and for lifting it out of the water. In addition, these heavy vessels would have sustained substantial hull damage and thus would have required frequent repairs. Herodotus, in his *Histories* (7.188), indicates in the incidental description of a set-back to Xerxes' fleet in 480 BC that if beaching was to be effective, the ship would need to be removed completely out of the water. Such a task would most likely need the effort of more than 30 strong men, sailors, warriors and oarsmen. (At this point it should be noted that warships carried larger crews than merchant vessels and were of lighter construction.) In the case referred to by Herodotus, the location chosen for beaching was a quiet bay north of the Greek island Euboea. A severe storm - Etesian wind - came without warning and destroyed a large number of warships. Etesian wind (probably "Meltemi" as known these days) are north-eastern winds blowing in July, August and September. Herodotus (6.140, 7.168 and 2.20) mentions them in connection with a Nile inundation. The seashore of Israel in the vicinity of Tel Michal is straight, without bays and would provide beaching as an option only during extremely calm weather. As in Greece, however, the sea conditions can change quickly and without warning. The problem of beaching a merchant vessel carrying a small crew of 4-6 men is immense; as already mentioned, it would require great effort to pull heavily built vessels, laden with merchandise, stone anchors

and ballast stones out of the water onto a beach, even considering the help of the local inhabitants.

The third possibility is that an arm of Nahal Gelilot, or of another stream from the marshland east of the *kurkar* ridge, may have been diverted to create and maintain a silt-free watercourse just east and south of the high tell, thus providing a channel for anchorage, as was common during the Bronze Age on the eastern Mediterranean shore. For this there are examples from the Bronze Age, with some minor topographical differences, at Achziv, Tel Nami, Sidon and other sites, where some harbours of this type have been discovered (Raban, 1987 a: 180). A later harbour of the Roman period at Selucia Pieria in Cumae north of Napoli (Erol & Pirazzoli, 1992: 320) exemplifies the perpetual problem of ensuring free-flowing water in this type of harbour. This harbour was built on a principle similar to that suggested above for Tel Michal. The coast at Cumae is also straight, without any bays, and consists of a hard rock base covered by sand deposits. From Lake Fusaro, which is to the south of Cumae, a canal was excavated into the natural lagoon. The original entrance from the sea to the lagoon was partially blocked by a pier, allowing a narrow opening on the northern end of the channel. The water flowing from Lake Fusaro, and occasionally from a creek leading into the lagoon, was thus channeled into the narrow passage, preventing the silting of the channel and of the harbour (Paget, 1968: 152-169; see Fig. 24).

Evidence based on historical parallels and on site research supports the possibility of an estuary-harbour to the south-east of the high tell at Tel Michal, fed and self-dredged to a degree by the diverted waters of Nahal Gelilot (Figs. 16, 17 & 21). There is also a possibility that when the wadi was dry, a trench was dug deep enough to reach the shallow ground water close to the shore which could then supply the required quantity of water needed to desilt the trench (Nir, 1994: pers. comm.).

Indications supporting this estuary-harbour theory were also found during the survey by the Centre of Maritime Studies, Haifa University in 1979 (Raban, 1979). Research performed by Gifford (1989: 209 ff, mentioned above in 6.2) established that the waters of Nahal Gelilot were flowing in ancient times in the same channel as today. Gifford's finds also indicate that in the past there was a body of water at the southern side of the high tell (Fig. 22). These two studies complement our research and suggest that an estuary-harbour existed south-east of Tel Michal. It is likely that during the Bronze Age some of the waters of Nahal Gelilot were diverted into the channel behind the high tell to maintain it clear for shipping, as was prevalent in Canaanite harbours (Raban, 1981 b: 48 ff).

The submerged rock crescent is clearly visible on photographs of the Tel Michal site (Fig. 16). A trench is also visible on the southern and eastern sides of the tell (Fig. 21). This trench encircles the high tell and turns at its eastern side towards the north. The trench was dug in antiquity on three known occasions, as part of a project of immense proportions. The inhabitants of Tel Michal used the excavated material to build their fortification rampart and a platform on top of the high tell at the beginning of Late Bronze I period. After part of the platform collapsed, at the end of Late Bronze I, the platform was rebuilt. Later, in Late Bronze II, when again some of the western part of the cliff on which the high tell is situated collapsed, the platform was rebuilt a third time (Fig. 19). Herzog calculated that approximately half of the original tell on the western side collapsed over the centuries, probably due to erosion (Herzog, 1989: 31). This weathering effect is obvious along the length of the coastline, where collapses occur from time to time until today (Fig. 25). According to Herzog's calculations the cliff, on which the high tell was primarily built, extended to today's waterline and reached the northern side of the submerged crescent.

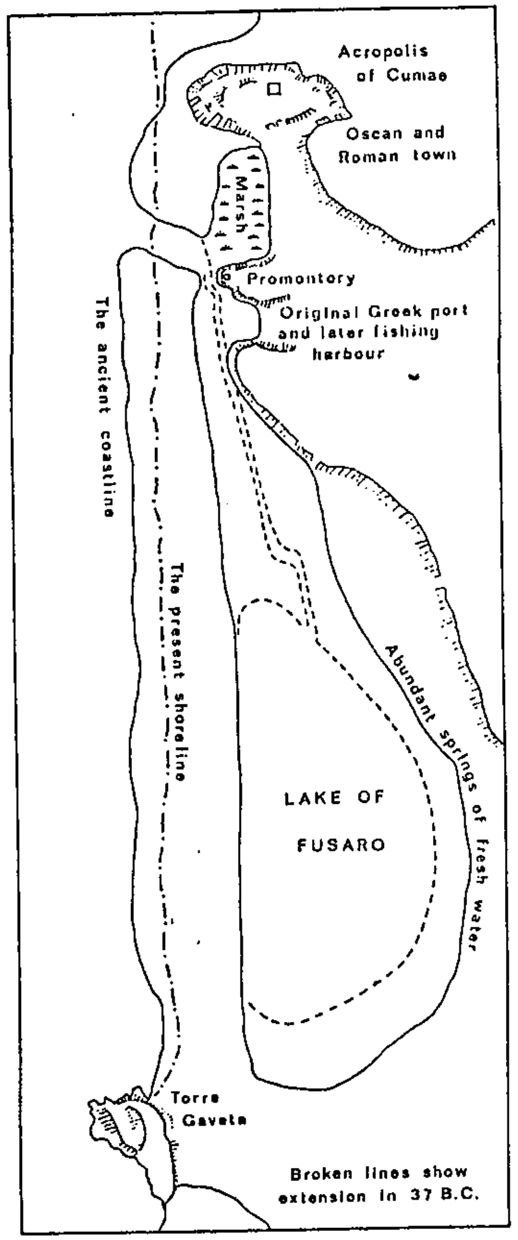

FIG. 5. CUMAE: THE GREEK HARBOUR
Drawn by Helen Waugh from sketch-map by the author

Fig. 24. Cumae. The Greek harbour (Paget, 1968:157).

Various researchers have addressed the question of the large scale and purpose of these excavations and the building of the platforms. According to Bakler (1989), the site geologist of the Tel Aviv University expedition, the material was extracted from the southern and eastern sides of the high tell. Herzog has calculated that 12,500 cubic metres of *hamra* have been used for the building of one platform, and a further 4,000 cubic metres for the glacis, plus another 15,000 cubic metres of sand, all taken from a source immediately to the east of the high tell. To do this the workers would have required 16,500 man-days to move and to place the hamra and 7,500 man-days for the sand, a total of 24,000 man-days. This means that it would have taken 200 workers about 4 months to complete the project (Herzog, 1989: 32).

The removal of the hamra alone would have left a trench approximately 8 m wide, 3 m deep and 500 m long. Rickman (1985: 108) states that "... in antiquity, and even in the whole period up to the 19th century, a 'good' harbour in the Mediterranean was not necessarily big or deep." In the Roman period a 30 m long boat "... would have needed a depth of little more than 3 m of water." The boats which are believed to have anchored at Tel Michal, were not longer than 10-12 m, meaning that a channel 3 m deep would have been ample. Flemming (*et al.*, 1971: 60) suggests that "... a useful harbour need only have been 2 m deep." The material from the trench at Tel Michal was carried up for the building of fortifications, and in our view, removed for the purpose of river diversion and the opening of a water channel. Though feats of this proportion were known in antiquity, material would not have been just carried up for the relatively cosmetic use of building a platform, to straighten the top of the tell and elevating the surface by approximately 2 m, as the top of the tell was already more than 20 m above sea-level. The main purpose for the excavation of the trench was to provide a passage and a safe harbour for all weathers. The partial abandonment of Tel Michal, and the subsequent disuse of the estuary channel, would have caused the silting of the passage.

6.4 Conclusion

In light of the absence of material evidence and considering the difficulties that faced sailors in ancient times, we exclude the possibility that ships at Tel Michal were moored in an inshore harbour or were beached on the shore. The town, considering its international trade, could not possibly rely on the occasional days when weather and sea conditions were favorable enough to allow approach to an exposed beach.

During the Middle Bronze II and Late Bronze periods it was common practice to divert wadi and river flows to build anchorages. The flowing water prevented silting which was a major concern for ancient harbour engineers. This can be seen at various sites including Achziv and Tel Nami, and the later example of the Roman port located at Cumae in Italy.

Geological findings based on wadi sediments at Tel Michal to the south and east of the high tell, indicate that there was water flowing in this area, supporting the deduction that an estuary-harbour existed there. It is believed that the inhabitants moved earth from this area for the subsequent building of three large platforms and the construction of fortifications. It is known that the whole area between the two *kurkar* ridges, one at the seashore on which Tel Michal and Apollonia are situated, and the second roughly 1.5 km to the east and 8 km in length, north to south, was marshland. The water from this area of approximately 12 square km could have been used to desilt the entrance of the estuary, where sand was accumulating by shore waves. It is also possible that when Nahal Gelilot was dry a trench was dug deep enough to reach ground water which could have supplied or supplemented the required quantity of water, essential for desilting the trench.

Vessels of the Bronze Age were constructed for use in estuary-harbours: ships were double ended, with identical stem and stern, and equipped with a single square sail. At any time during the day, with the prevailing western winds, ships could enter an estuary-harbour running before the wind. In the morning, when the breeze blows from the land, ships could put out to sea, again with the wind behind them, requiring only the shifting of the oar-rudder from stern to stem (Raban, 1980: 752 ff; Landstrom, 1970; Gottlicher, 1985).

Considering all these facts, we may conclude that there might well have been an anchorage at Tel Michal, located in an estuary-harbour to the south and south-east of the high tell. It was there where ships would have found secure shelter and could have conducted their trade. Entrance to the harbour opening would have been via the gap in the southern end of the rock crescent (Figs. 16, 17 & 21).

Further land investigations on the southeastern side of the high tell are required. Should this work be implemented, we would anticipate to uncover evidence indicating the presence of an ancient flow of water into the sea on the eastern and southern sides of the high tell of Tel Michal. In addition, pottery finds therein would provide dating indicative of the period concerned.

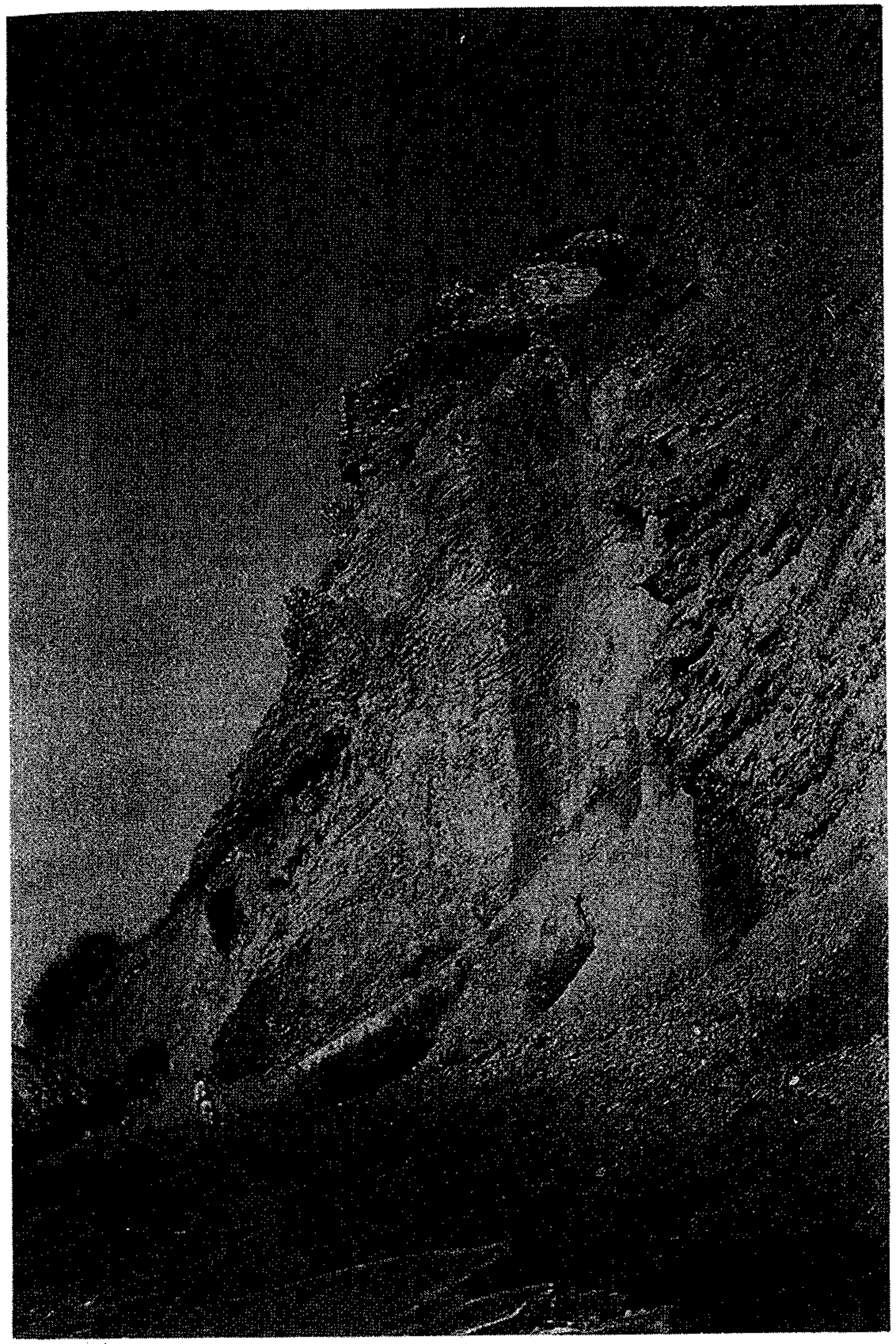

Fig. 25. Apollonia. Debris sliding from the Crusader fortress.

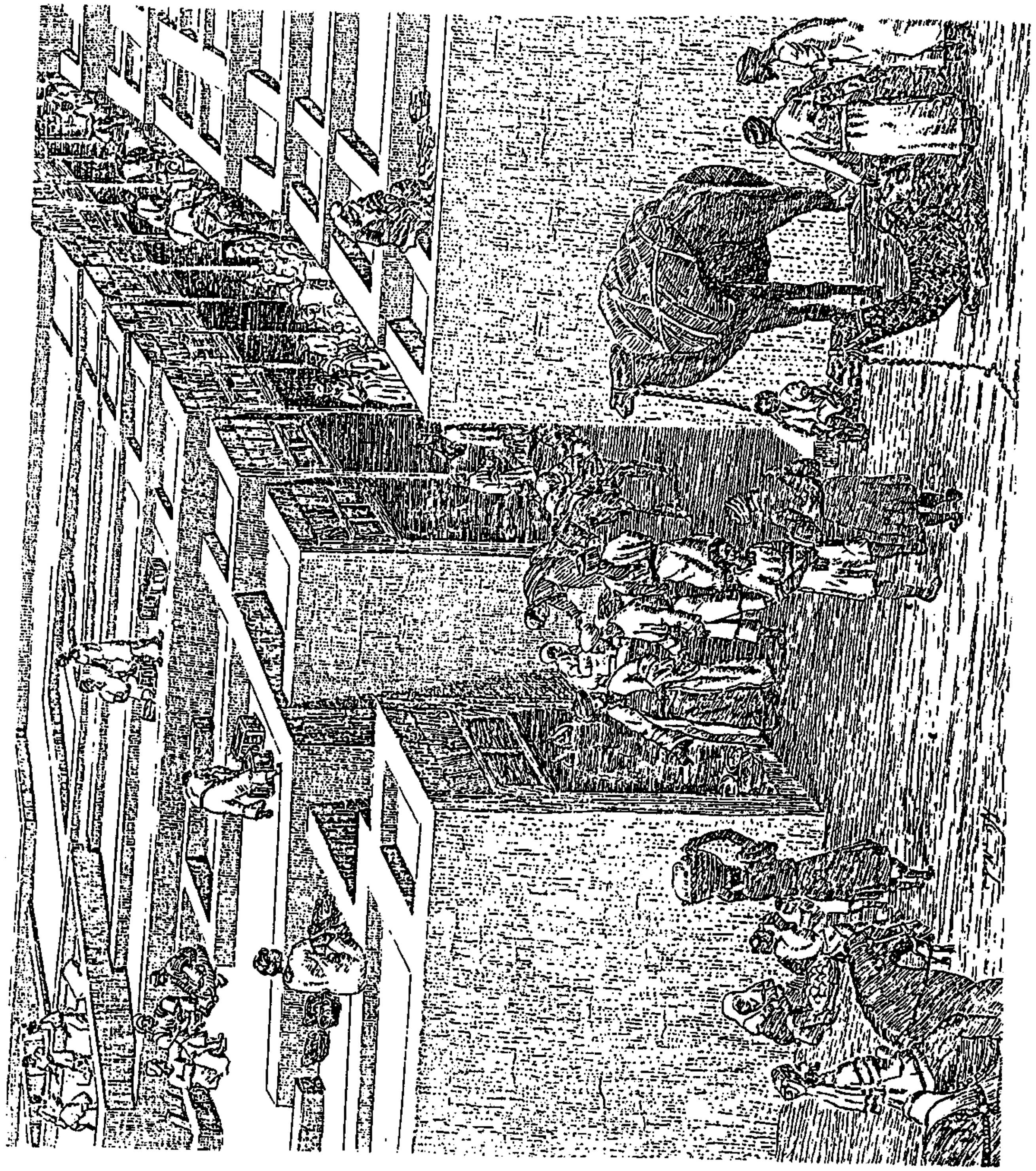

Fig. 33. Reconstruction by Anna Yamim of the Early Islamic market street, looking north.

Fig. 34. Crusader castle and port prior to the recent excavations, looking east (courtesy of R. Cleave).

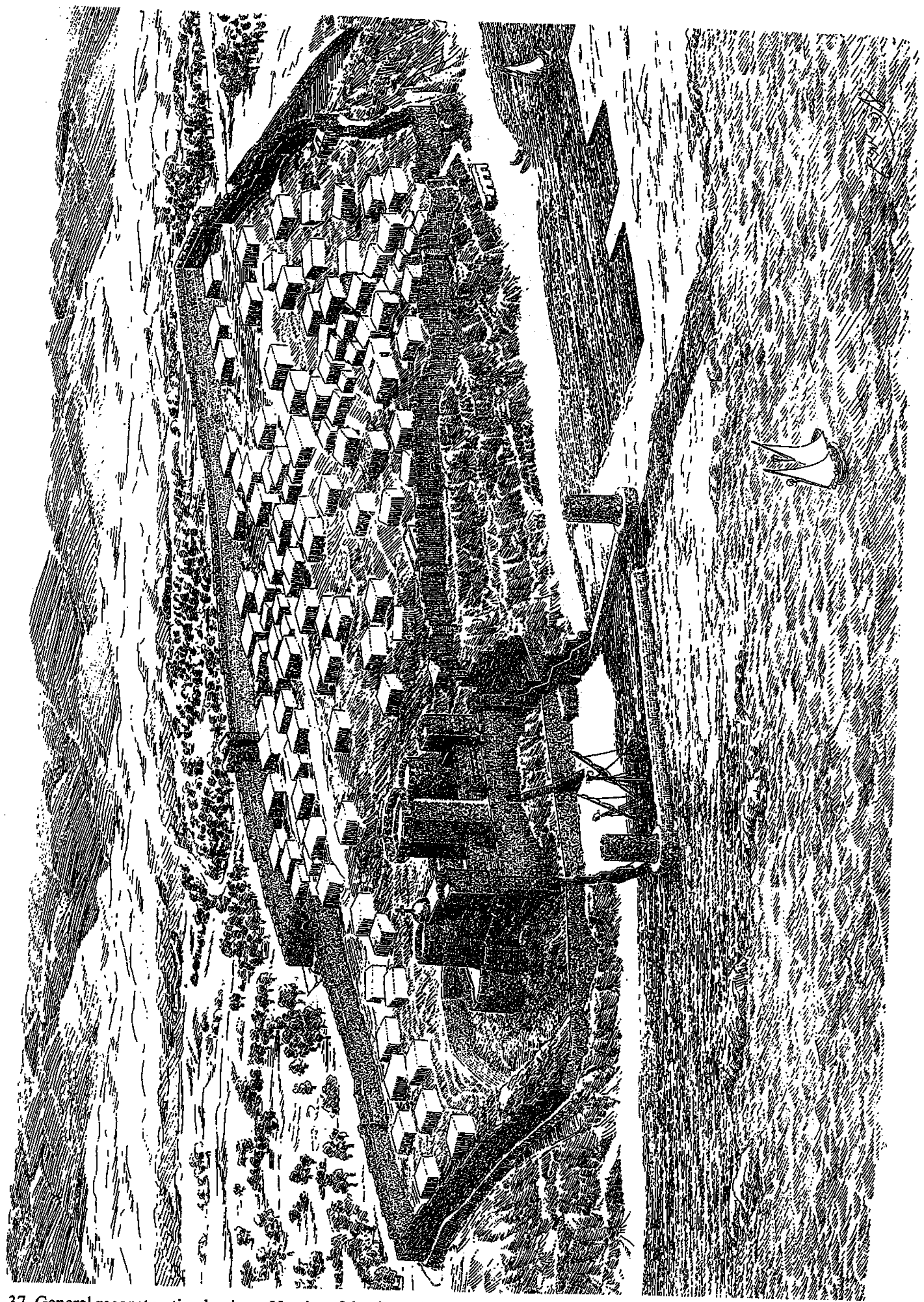

Fig. 37. General reconstruction by Anna Yamim of the Crusader site and its maritime facilities.

CHAPTER 8

MARITIME APOLLONIA

8.1 Background

Apollonia is located 3.5 km to the north of Tel Michal and was built on the coastal *kurkar* cliff, into which four wadis were cut by erosion. On the highest point of the *kurkar* hillock a Crusader fortress was built which overlooks a narrow band of beach and a distinct basin to the west (Figs. 15 & 38).

The site was first occupied during the Persian period and reached its peak in the Late Roman and Byzantine periods. Most cities in the Sharon region reached their zenith at that time. This was also a period, when pilgrims came through the port of Jaffa to Jerusalem (Hunt, 1984). Afek, on the other hand a town in the southern Sharon on the main road to Jerusalem, remained during this period inexplicably poor (Kochavi, 1990: XXIX). Archaeological discoveries and historical documentation confirm an increase in maritime activities in the 5th and 6th centuries AD, and hence a new importance for the seaside centers. The conflicts between the Byzantine and Muslim powers of this period led the Byzantines to increase their naval fleet, and later in the 7th century, the Muslims established theirs. Trade in spices and of luxury goods, brought from the Far East to the Mediterranean and to the Black Sea, played a major role in these conflicts (Lewis, 1951: 19-20, 54-163; Fahmy, 1966: 69-114). The Crusaders and the rise of Pisa's and Genoa's maritime and economic strength in the 11th and the following centuries had an immense effect on the trade in the Eastern and Western Mediterranean waters (Lewis, 1951: 247). These maritime activities, here only briefly mentioned, confirm the importance of harbours and anchorages along the Eastern Mediterranean coast during this period.

Extensive land surveys and excavations have been conducted at the site by I. Roll (Roll & Ayalon, 1989). He has demonstrated that the town reached its peak during the Byzantine period when Apollonia was one of the main economic, industrial and agricultural centers in the Sharon Plain. The main roads from inland, including Samaria, Nablus and Jerusalem through Antipatris, led to this town. Apollonia's harbours linked it with overseas ports and opened it to foreign influences, thus enhancing its importance. The main north-south coastal road passed close to the east of the town (Fig. 14).

The objective of our investigation was to resolve several central questions regarding the harbour or harbours at Apollonia:

(1) Was the so-called "Crusader Harbour" located at the base of the high tell really a harbour, or was it a lower castle?

(2) What positive proof could be found regarding the assertions made by various researchers that Apollonia had an anchorage to the south of the "Crusader Harbour" (Roll & Ayalon, 1989: 63 ; Fig. 38).

In this section it will be argued that two harbours existed in Apollonia during the Late Roman and the beginning of the Byzantine periods. The first harbour, termed the "Crusader Harbour"[1], was well protected by piers on its northern and southern sides and by a breakwater to the west. The harbour entrance was at the southern end of the breakwater, allowing self-desilting by utilizing natural currents (Figs. 39 & 40). The second harbour, termed the "Roman Anchorage" was located to the south of the town and also possessed an entrance at its southern end and breakwaters to the north and west. The unusual southern entrance to both harbours may be explained by research conducted by marine geologists (Chap. 2 & Fig.9).

According to Roll and Ayalon (1989: 232) the settlement of Apollonia spread to the southern side of the hill during the Roman period and occupied an area of about 65 hectares. An inshore area 250 m to the south of the "Crusader Harbour", 250-300 m along the shore and extending 150-200 m into the sea was sheltered and has been termed the "Roman Anchorage" in this study (Fig. 40). Local fishermen found in this zone pottery sherds and parts of amphorae dating to the 5th-6th centuries AD (Fig. 41).

This area forms a basin, open to the south and protected by naturally occurring rocks on its western and northern side, an extension of a line of natural rocks from the "Crusader Harbour". At its northern extremity is a small natural bay, and next to it a recently created tombolo, still accumulating sand and growing. The southwestern side of the tombolo and the natural bay has been used during good weather by fishermen as an anchorage (Fig. 42). When the seas are high, the fishermen do not beach their boats, but carry them to safety up to their huts, completely out of the water. Another tombolo is presently being formed to the south of the natural bay.

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1 The terms "Crusader Harbour" and "Roman Anchorage", as well as the associated terms "pier", "breakwater", etc., are used herein only for convenience of reference and do not imply a presumption of results. These references are useful as reminders of the questions posed throughout this work in respect to the two areas.

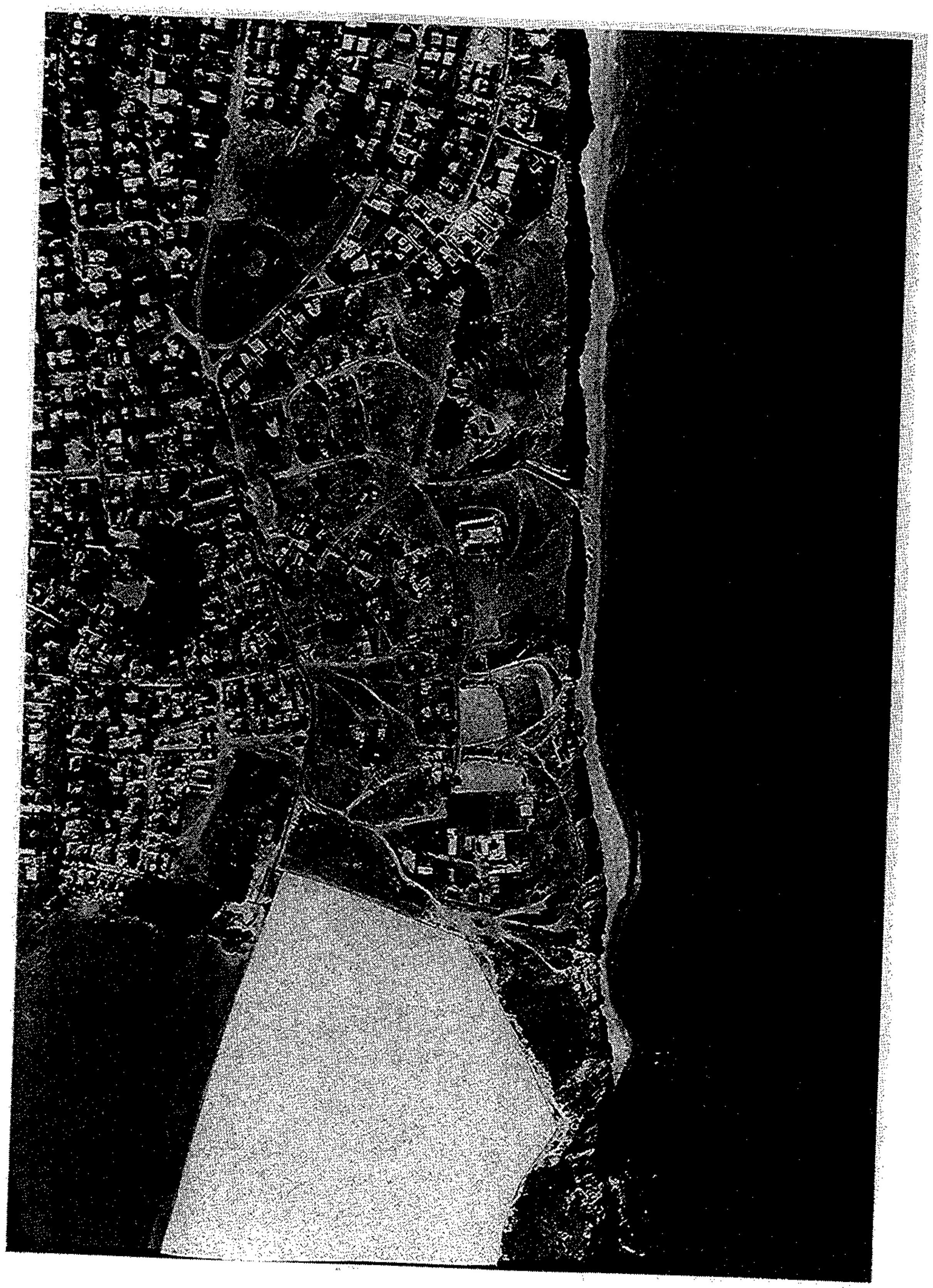

Fig. 38. An aerial photograph of Apollonia, 1989. Note the fishermen's huts on the slope and their boats in the sea. The submerged rocks continue from the "Crusader Harbour" southwards to the "Roman Anchorage". The entrance to the anchorage is at the southernmost point of the submerged ridge. The rocks near the shore represent Area B.

Fig. 39. View to the north-west, towards the harbour below the Crusader fortress. On the southern side of the western breakwater is a 10 m wide gap, the entrance to the harbour. Today it is blocked by debris of the southern tower which was still standing until 1955 (Fig. 5). Inside the basin are parts of walls that collapsed from the Crusader fortress.

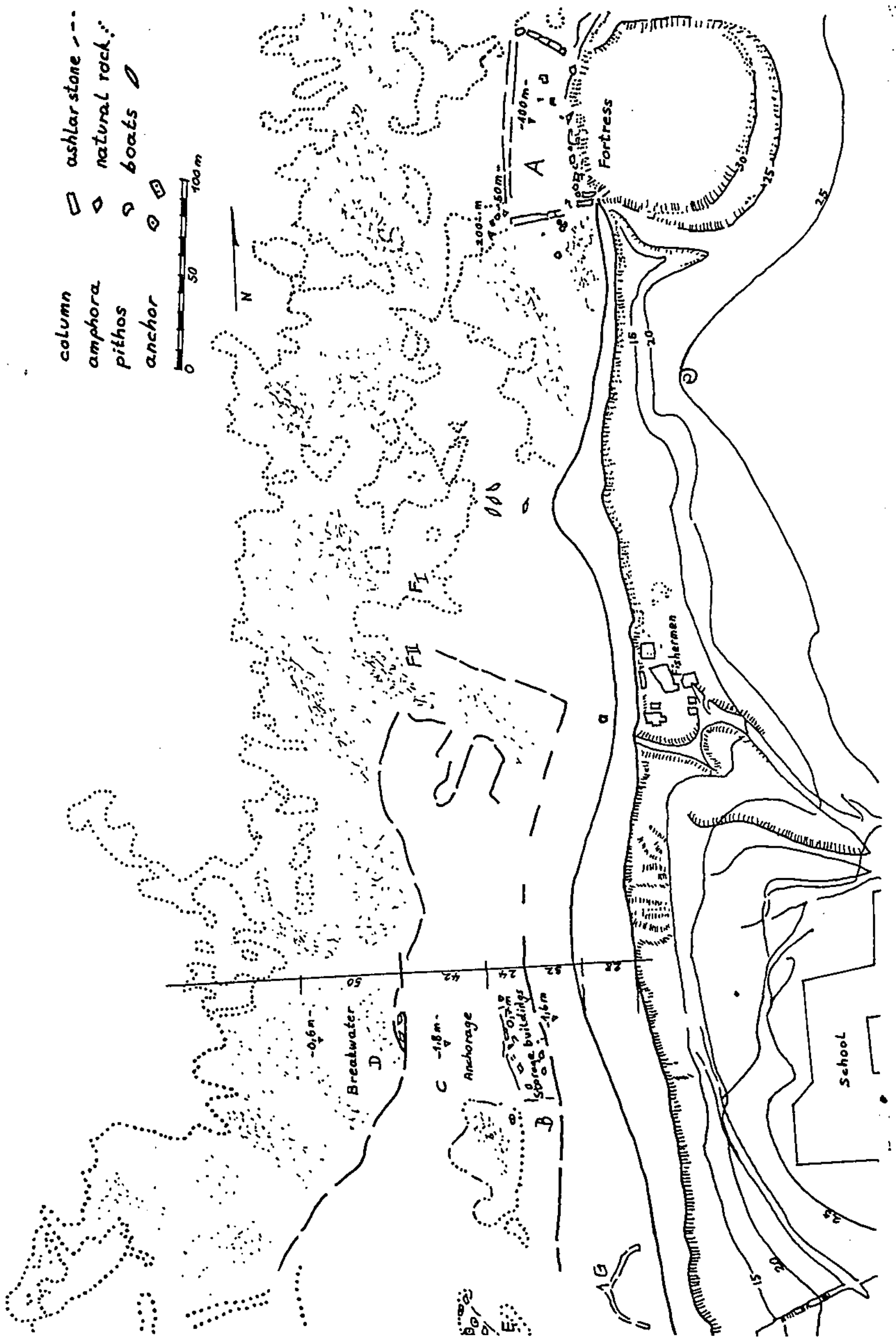

Fig. 40. Map of Apollonia's harbours based on an aerial photograph and a field survey.

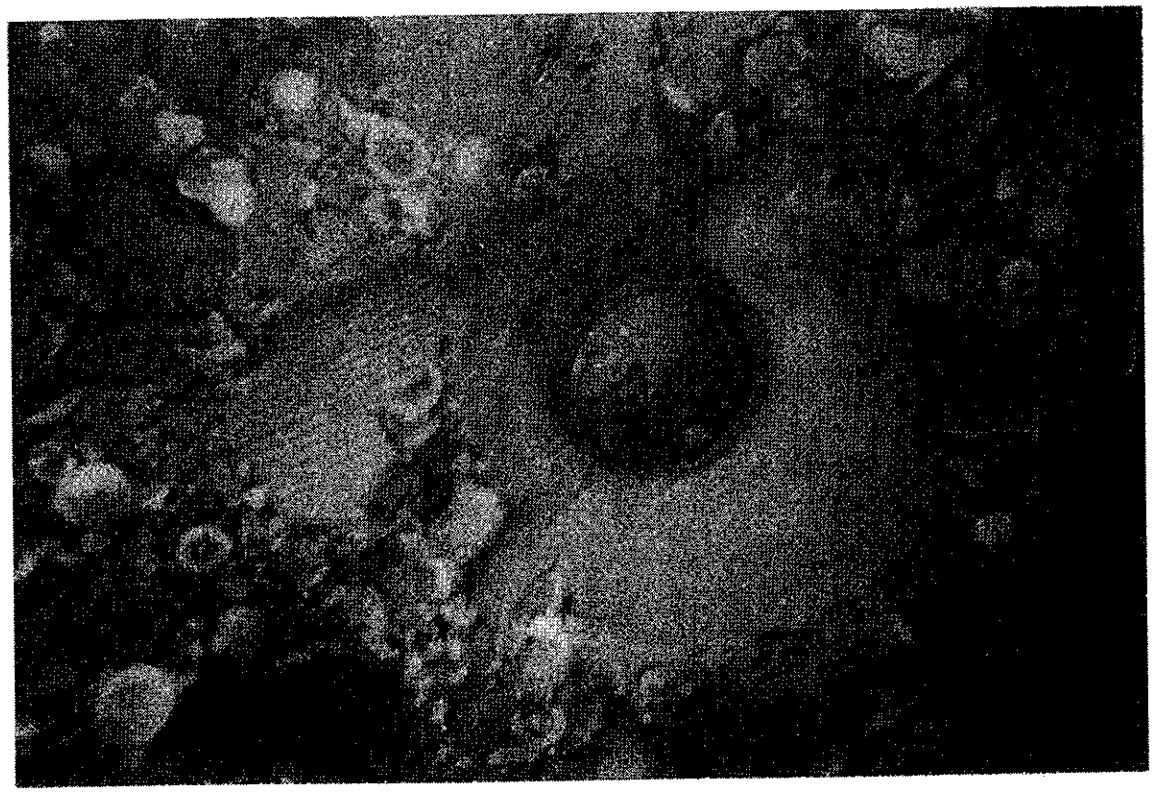

Fig. 41. Byzantine amphorae *in situ*.

Fig. 42. Apollonia, fishermen's anchorage, today.

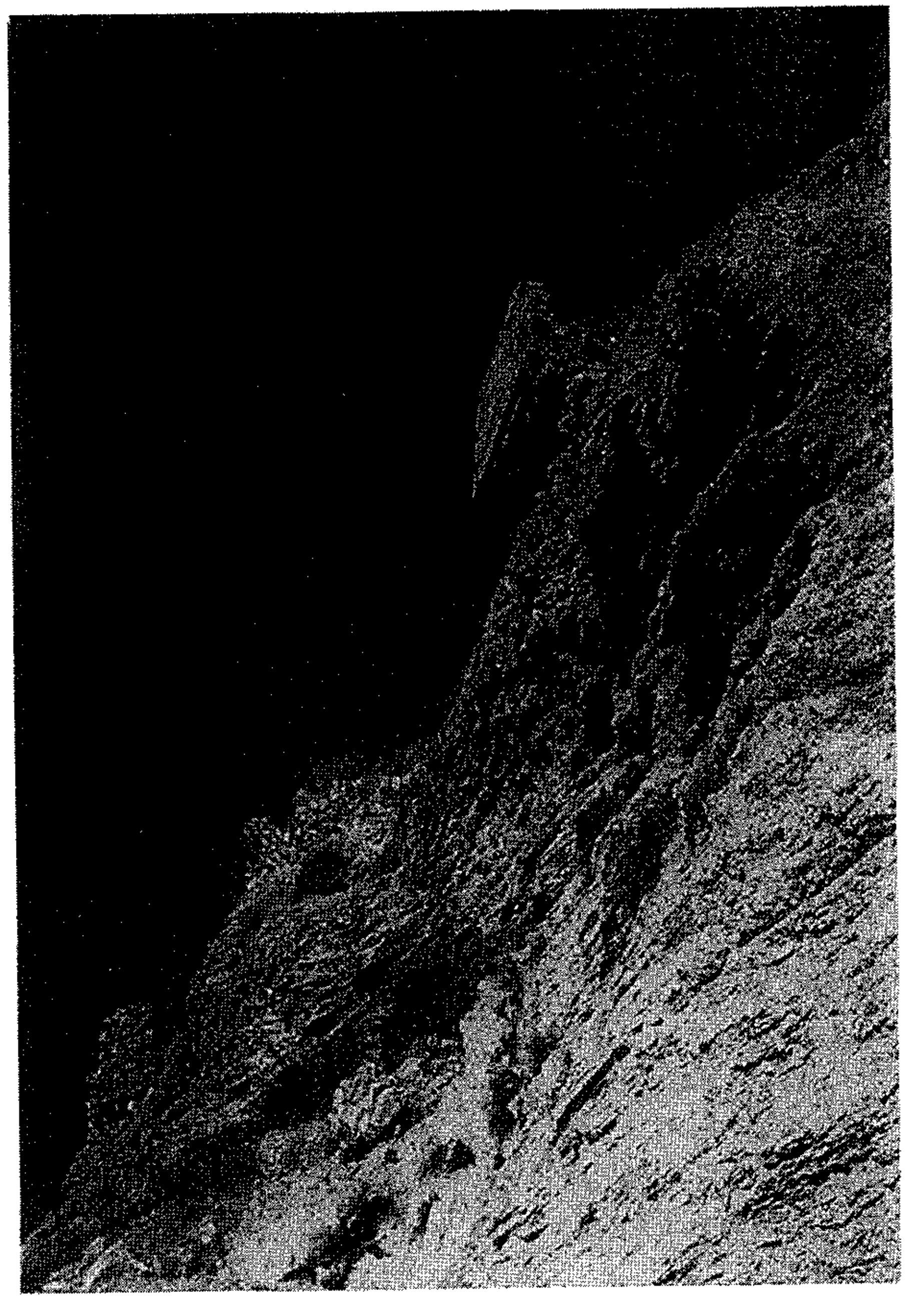

Fig. 43. Apollonia, part of a wall from the Crusader fortress, hanging on the cliff.

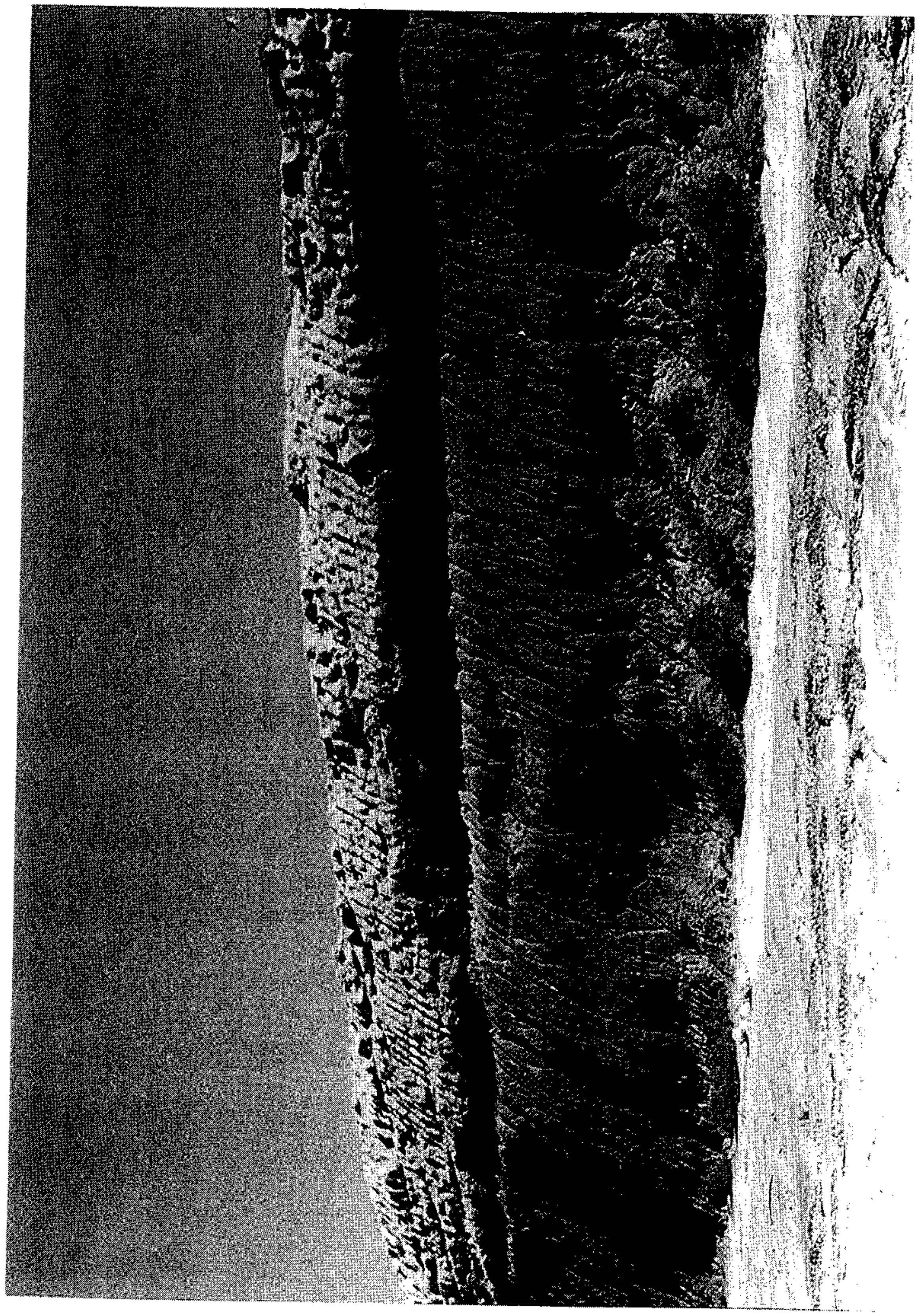

Fig. 44. Layers of *kurkar* and *hamra*, Tel Michal.

The Crusader fortress is situated on the northern outskirts of the ancient town, topographically the highest point of the site. According to Roll & Ayalon (1989: 106) the Crusaders fortified the castle with towers and with double walls, forming a moat on all sides except the west. The castle was built on the extreme edge of the cliff and as the cliff eroded over the centuries, parts of the castle collapsed onto the narrow beach and into the sea (Figs. 39 & 43).[1]

Access to the city from the west was prevented by the steep cliff. A tunnel was excavated to connect the fortress with the seashore. Roll & Ayalon (1989: 112-114) describe the inner fortification wall as extending 35 m westwards into the sea and forming two piers, each bearing a round tower at its end (Figs. 39 & 46). The basin is protected from the open sea by a breakwater, thus creating a safe anchorage. At the southern end of the breakwater is a gap approximately 10 m wide. As this basin lies directly below and in line with the fortifications, Roll and Ayalon assert that it was built by the Crusaders.

The "Crusader Harbour" was surveyed by Raban and his team from Haifa University, who concluded that the enclosure served as a "lower fortress" rather than as a harbour (Raban, 1979). Furthermore Raban argued that during the Crusader period the water level was approximately 1 m lower than today's, presumably leaving the basin dry (Figs. 10 & 11).

8.2 Site investigation of the "Roman Anchorage"

As is true of the shore at Tel Michal, sand sediment overlaying the "Roman Anchorage" at Apollonia is subject to rapid and dramatic shifts due to currents and wave action, with corresponding changes in water clarity and sand deposition; this can fluctuate by up to +/-1 m (Chapt. 2). While we dived at the site at every opportunity when conditions of clarity and calm prevailed, storms created dramatic and completely unpredictable changes in the depth and distribution of sand. A patch of reef free of sand on one occasion might become deeply covered the following day and in some cases may remain concealed for the remainder of the season, while another area might be suddenly cleared of sand. Thus the basin revealed itself sparingly, requiring a quick survey when conditions were favourable, and with the recording of finds having to be compared with previous work. Find spots were marked by a buoy, an empty bottle on a rope fixed by a stone, and two or more magnetic bearings were taken. The method was not sophisticated, but merely functional[2]. The survey of the "Roman Anchorage" represents the piecing together of a highly complicated and varying puzzle, only a few pieces of which were revealed at any given time.

The investigation of the "Roman Anchorage" proceeded in two stages. The preliminary stage consisted of the surveying of the general features of the site, with specific emphasis on the nature of components which formed the breakwater to the west of the anchorage in Area D (Figs. 40 & 55). Secondly, each area which became exposed naturally when the sand cover disappeared was surveyed, and if found to be of interest, photographed and mapped.

Nir and Roll (pers. comm.) assert that if the rocks, to the west of a line connecting the westernmost extremities of both ancient harbours (Figs. 38 & 40), were composed of beachrock, it would been likely that the beach was in fact in existence when the rocks were forming indicating a lower sea level. Evidence indicating the period when this occurred might then be found by dating the pottery sherds (provided they are of sufficient size) if present in the beachrock (and if the rock turned out to be beachrock). Should the rocks prove to be of an origin other than beachrock, we would find support for the presence of a bay having existed in antiquity.

Following Nir and Roll's advice, a sampling survey was set up at a distance of 80-100 m from the current shoreline. Four main areas were sampled along the line suggested by the scientists: two areas 100-120 m to the south of the end of the southern pier of the "Crusader Harbour", to the north of Area F (Fig. 40); and two areas located about 200 m further to the south, in Area D. Representative samples were taken from the first two areas. This required great effort, as it was very difficult to break the rock. No pottery lodged in the rock was discovered at any location, despite the fact that the "Roman Anchorage" at Area C was littered with Byzantine pottery. Examination of the samples by Nir revealed that they were not beachrock, but other sedimentary rocks including grained marble which is not local. All rocks were encrusted with a covering of biological origin, 1-2 cm thick.

These samples were taken about 50-60 m to the north of Area F where the rock is unlikely to be a remnant of a beach or of processes associated with the presence of a beach and were found to be natural rock and support the conclusion that during the Byzantine period the sea level was in fact approximately 1 m higher than today (Sneh & Klein, 1984: 831 ff).

The character of our work changed following a significant find in Area B, where a cluster of architectural debris lying parallel to the coastline was discovered within an area measuring approximately 50 m from north to south and 20 m in width (Fig. 40). Items discovered included many ashlar stones, and pillars measuring 0.30-0.50 m in diameter, made of basalt and marble. A very large quantity of pottery sherds were also found scattered amongst these architectural remains, predominantly from the Byzantine period, though there were also some sherds of storage jars and pithoi from the Late Roman period.

The area to the west of this group, Area C, was free of architectural remains and its solid rock bottom slopes

[1] Goldsmith & Golik (1980: 149) explain that the coastal cliffs along the length of the Israeli coast are made of *kurkar* imbedded with *hamra*. They are eroding at the toe of the cliff due to wave abrasion, wind action and by washout of the soft hamra by rainwater (at Tel Michal see Fig. 44 and at Apollonia see Fig. 43).

[2] Modern equipment was used for example at Torone (Samiou *et al.*, 1993), where the mapping was conducted using a Sokkisha Set 3 electronic theodolite; and see the various survey techniques outlined by Green (1990: 23 ff).

Fig. 45. Apollonia, breakwater, Area D. Part of the man-made stone wall.

gradually to the west from a depth of 1.8 m to 2.5 m below sea level. Further into the sea, Area D, the "breakwater" was investigated. It enclosed Area C from the west. The "breakwater" is a major feature of the "Roman Anchorage", measuring about 50 m in width and 250-300 m in length from north to south (Fig. 40). This massive conglomerate led us to assume that it could not be of natural origin because it was covered with many scattered ashlars and foreign ballast stones (Nir and Bakler 1991, pers. comm.); cut-off corners and edges of stones were visible, all encrusted and joined into seemingly natural rock (Fig. 45). Large quantities of pottery sherds from this location were dated by Roll to the Late Roman and Byzantine periods (pers. comm. 1991).

The "breakwater" was examined in the 4th season of our survey, in September 1994. It was built on a natural ridge of sedimentary rock which slopes gradually from the "Crusader Harbour" in the north, where it is at water level, and extends southwards to Area F (Fig. 40) where it reaches a depth of approximately 2 m and continues on the sea floor for about 150 m at the same depth. At the southern end of this ridge, where the rock disappears were found large stones 1.50-2 m lying parallel to each other in a north-west to south-east direction. They seem to be the visible part or the remains of a larger number. Huge blocks of hewn *kurkar* stone, some measuring 0.6x0.6x0.6 m were thrown or built on top of the ridge and a quantity of ashlar sand-stones 0.4x0.4x1.2 m placed over them. Analysis of these ashlar stones by Y. Nir indicates that they are not of local provenance. It is possible that these stones constituted the upper surface of a breakwater. Due to damage by continuous erosion and water movement, it is not clear how this surface was built. The possibility exists that an artificial structure composed of ashlar stones was built on natural rock, as at Sidon (Muckelroy, 1978: 76).

The ashlar blocks from this breakwater are today scattered over an area 50 m wide. Considering the destruction by water movement and earthquakes which occur in this area it appears that the breakwater was 20 m wide and that the above described forces scattered the stones on both sides over a distance of about 15 m.

8.3 Site investigation of the "Crusader Harbour"

The investigation of the "Crusader Harbour" at Apollonia was conducted along the same lines as at Tel Michal. We began with a general photographic survey of the site from the cliff-top on which Apollonia is situated. Looking from the site of the ruined Crusader castle, the enclosure of the basin can be easily distinguished (Fig. 39). When the sea was not too rough, it was possible to measure the exposed remains of the "Crusader Harbour" and when the sea was calm we could conduct underwater investigations as well. Large pieces of masonry debris from the fortress' walls had collapsed and slipped down the cliff to the eastern side of the basin. The piers extend approximately 35 m in a generally western direction ending at a 94 m long breakwater which links the two pier ends, thus enclosing the basin. At the southern end of the breakwater is an opening, about 10 m wide.

The northern pier of the "Crusader Harbour" juts diagonally into the sea to the north-west; it is 35 m long and 4 m wide (Figs. 46 & 47). The northern side of the pier is still well preserved and reaches a maximum height of 2.10 m above today's sea level. It was built from rubble and undressed stones and was surfaced by 0.2-0.25 x 0.3 x 0.3 m and 0.2-0.25 x 0.3 x 0.6 m ashlar stones on foundations in a fashion described by Vitruvius in the 1st century BC (Book V: XII) where he described harbour building methods. Frames made of heavy timber tied with chains were lowered to the seabed and firmly fastened. A mass composed of two parts of volcanic ashes and one part of lime together with an aggregate of stones was placed into the frames and lowered to the seabed where it solidified into a concrete-like substance. After the hardening of the mass, the wooden frames were removed, whenever possible, so that they could be re-used. More stones and gravel were then placed around the cast foundation to obviate erosive effects and undermining by waves and sand. The volcanic ashes (lava) were probably imported from Italy.

During several dives a detailed search was made for remains of timber used in the foundations of the northern pier, so that we could establish an accurate radio-carbon dating. None, however could be found and it is assumed that any wood would have been destroyed over the centuries and by recent pollution of the site (Fig. 47).

An interesting phenomenon was a constructive feature of the foundation casting that was also used to desilt the harbour. The frames were necessarily heavy and clumsy and the thickness of the timbers, plus the chains, resulted in, after following the removal of the frames, adjacent foundation blocks being separated by gaps of various widths. These were not filled by the builders and even continued into the walls up to water level, forming more or less vertical slots allowing water to flow through the basin (Figs. 46 & 47). These irregularly spaced slots can clearly be seen, reaching from the seabed through the cast foundation and into the wall. Thus a functional feature was created, using the southern longshore current, as outlined above, reversed by the local nodal point, to automatically desilt the harbour. Such self desilting installations can be traced at many places such as Caesarea in Israel (Raban, 1981 b: 73-77), or at the Early Roman harbour of Cosa in Italy (Lewis, 1971: 238). The piers at Apollonia, as was usual at that time, consisted of an outer and inner wall of ashlar masonry, the space between them filled with a mixture of mortar and pebbles.

The Herodian harbour at Caesarea was similarly constructed with variations of the method as outlined by Vitruvius (Raban, 1981 b: 73-77. Ongoing investigations of precise construction techniques used at Caesarea continue to offer surprises (cf. Brandon, 1994: 5). A chemical analysis of the waterproof cement used there has now been published by Oleson (*et al.*, 1992). The utilization of the same kind of "concreting" technique can be clearly observed at Apollonia, where the marks of the wooden frames are still visible in the foundation blocks. The Claudian port of Ostia and Lepcis Magna also utilized the same method (Raban, 1981 b: 65-66).

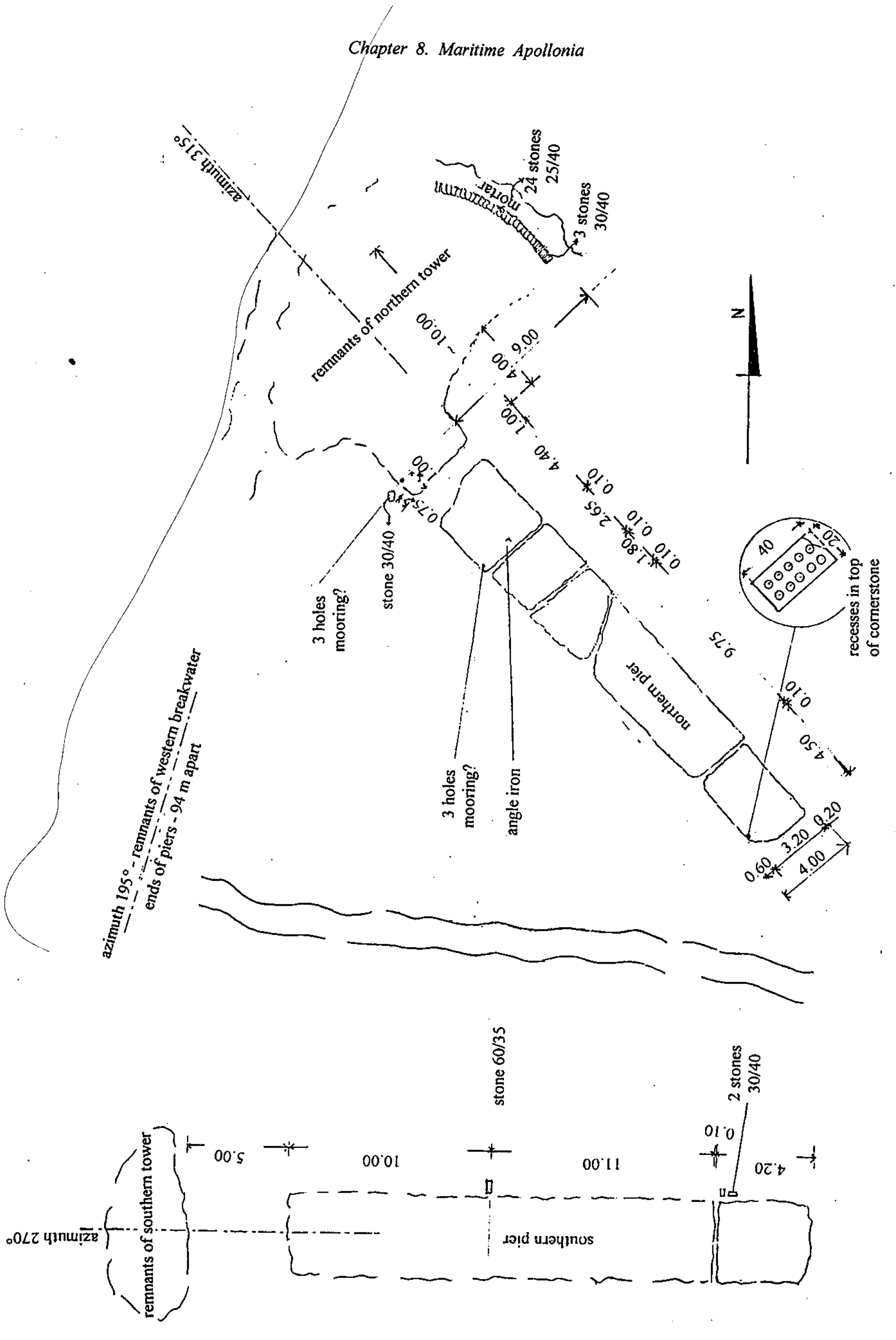

Fig. 46. Apollonia, plan of the piers.

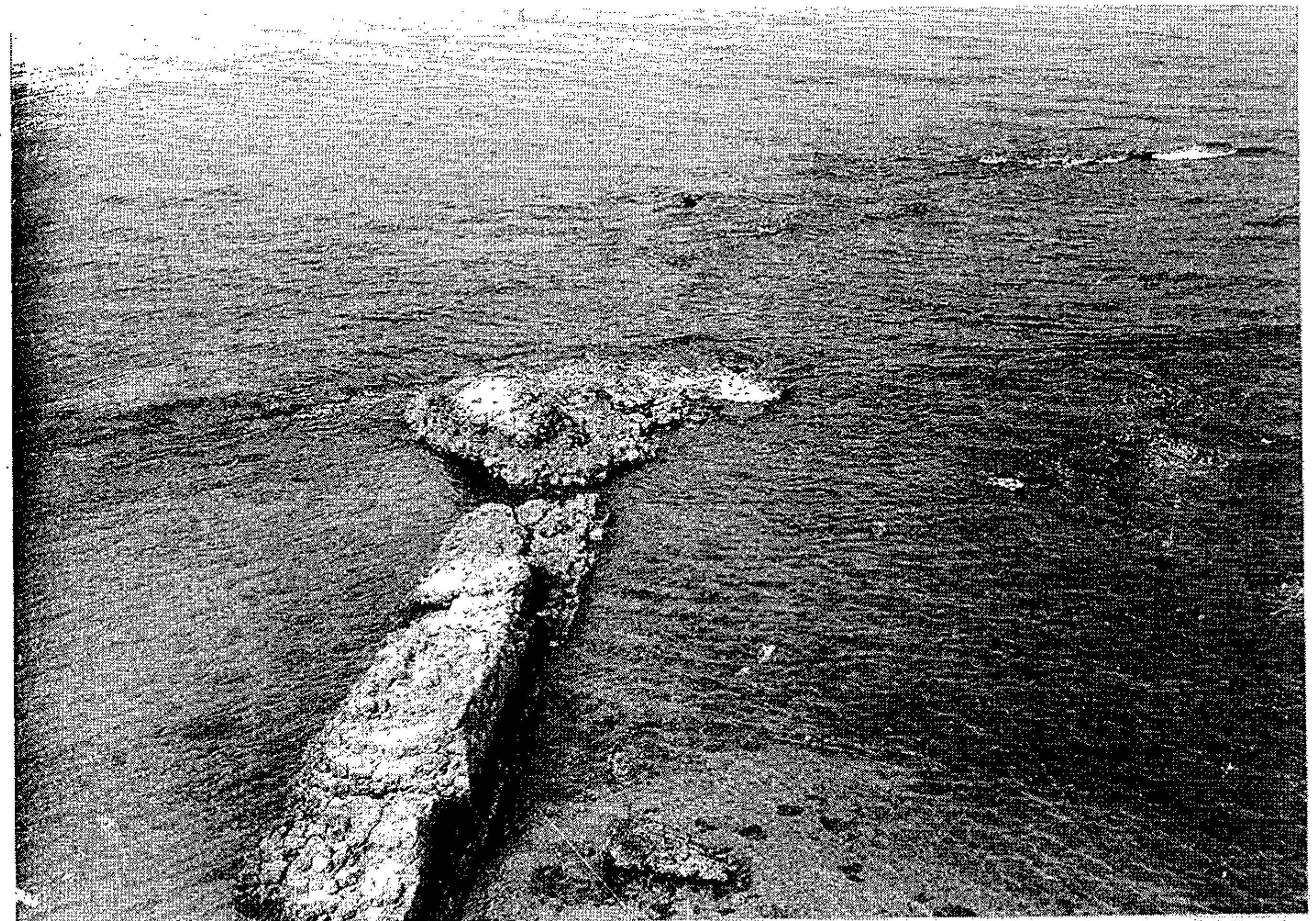

Fig. 47. Apollonia. View to west. The northern pier of the "Crusader Harbour". To the right of the pier is a puddle of polluted water flowing from the north.

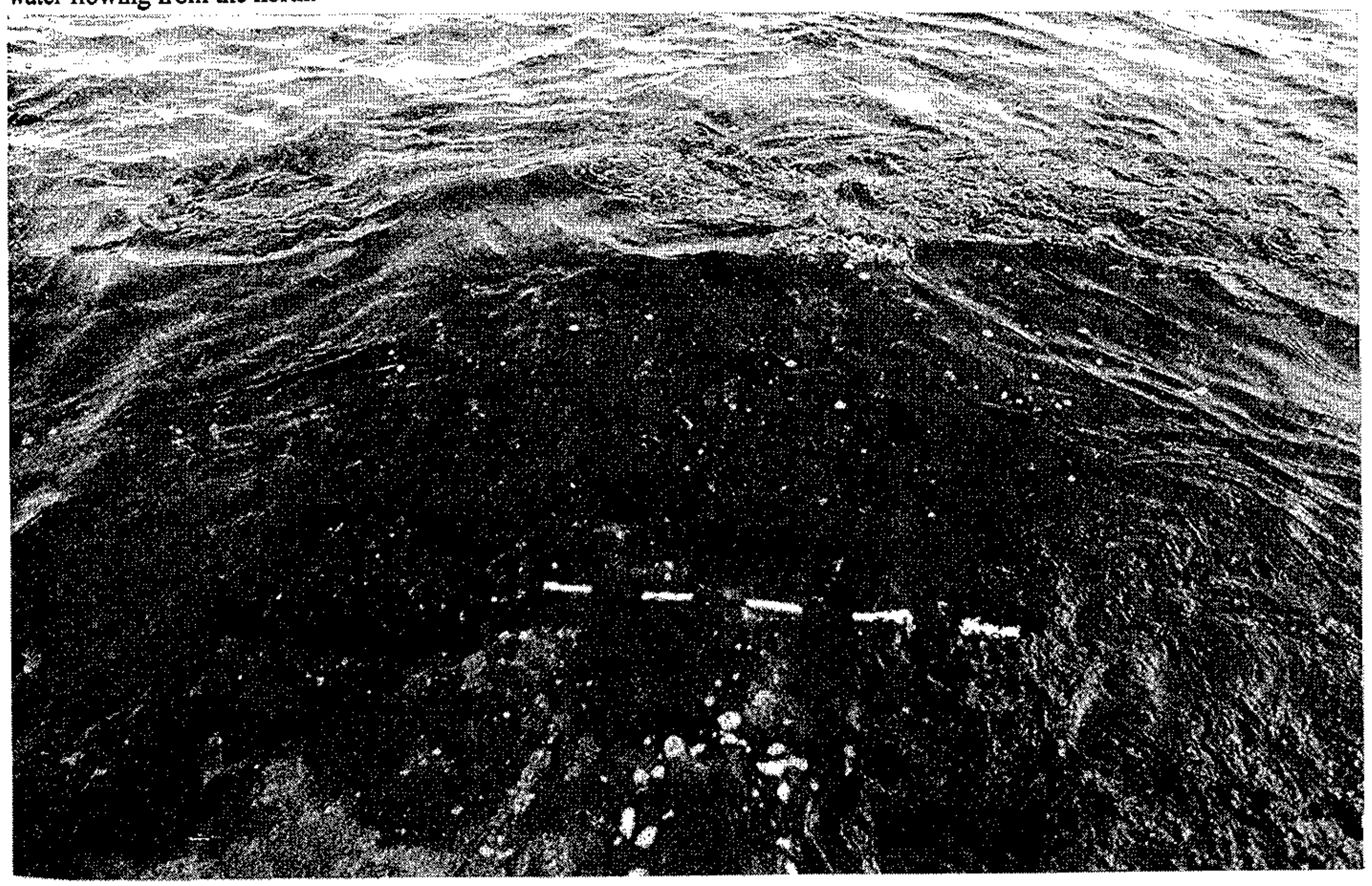

Fig. 48. Apollonia, foundations of the northern tower.

Roman harbours commonly consisted of an inner and an outer harbour (Lewis, 1971: 233), a design adopted from the Hellenistic harbour builders and originating from the Phoenicians (Blackman, 1973: 115 ff). (Double harbours: the outer termed an *emporion,* with full facilities, was for the merchant and visiting ships which were charged a fee; and an inner harbour, called a *neorion* used by warships and local vessels). Merchant ships needed safe harbours to protect them both from storms and from enemy fleets. On the other hand, Aegean light vessels, mostly warships, were at that time preferably beached rather than left to ride at anchor (Herodotus, 1985: 7.188; Homer in the *Iliad* Book II. lines 151-154). This was made possible by the light construction of these vessels, and the large number of crews (Raban, 1981a: 18). The ever increasing role of vessels in the many Greek military activities, made the speedy lowering of galleys into the water an essential feature.

During Roman times, boats used on the East Mediterranean coast were of a design and construction similar to the Hellenistic vessels. The continued use of the older designs was due to their high level of maneuverability which was required when entering and leaving the relatively tight ports on the Eastern Mediterranean coast (Rickman, 1988: 257-267; Williams, 1976: 73 ff).

In the Byzantine period, harbour building was based mostly on utilizing harbour sites from previous periods by adapting them for current use. Construction methods, on the whole, were less regimented and precise than those used during previous periods. But the description which Procopius of Caesarea[1] gives in his book *De Aedificis,* interpreted by Hohlfelder (1988: 54 ff), points to the continuing use of construction methods such as those described by Vitruvius. Procopius described the construction of two harbours in the Bosporus, at Heraeum and Eutropius, where "... wooden chests or boxes were filled with stones, floated into position, and somehow sunk in place, ... set in layers, one course on top of another". Hohlfelder points out that an easier way to build such a structure, would be to start building from the shore and to continue into deeper water, so that "... the finished portion of the breakwater becomes the working platform for the next seaward section". The Caesarea harbour was renovated during Anastasius' I reign (6th century) when "rubble was piled along the southern or inner side" (Hohlfelder, 1988: 54 ff). It seems that during the Byzantine period Roman harbours were repaired, or if new harbours were built the construction method consisted in dumping stones from boats at the desired location or scuttling ships, as was done in Ostia, Rome's imperial harbour (Blackman, 1974: 101-136; 1982: 79-104 & 185-211). Hohlfelder (1988: 54 ff) has stressed that the general state of "...archaeological investigations of Byzantine harbours are embryonic". We feel that the full-scale excavation of the Apollonia site would significantly expand knowledge of the subject, because our survey has only provided an indication of the potential encapsulated there.

[1] Greek historian and Byzantine official, native of Caesarea in Palestine, born c. AD 500 and died after 560.

The northern pier of Apollonia's "Crusader Harbour" terminates at its tip with a round tower, about 18 m in diameter. The foundation on the northern side of the tower base consists of two layers of hewn stones forming a perfect 4 m long crescent (Fig. 48). The lower layer is built of 0.3 x 0.4 m stones, while the second layer is built of smaller stones 0.25 x 0.3 and 0.25 x 0.4 m. On the side facing the sea (the northern side) the stones are joined by mortar. The tower, like the northern pier, was most probably destroyed over the centuries by wave action, earthquake and neglect, or perhaps during the 13th century siege of Apollonia by the Mameluks.

The southern side of the northern pier is less well preserved, but two items of interest were discovered. Firstly, a flat rectangular stone, 0.2x0.4 m, with 10 recesses on top, seemingly in secondary use, was found embedded about 1 m from the southeastern corner of the pier (Figs. 46 & 49). It was probably used as the playing board of an ancient game, still played in recent centuries (Roll & Ayalon, 1989: 108). Similar items have been found at various sites, especially in public areas, such as the steps flanking the southern side of the Roman forum at Macedonian Philippi (Hillard, 1994: pers. comm.).

Secondly, three other peculiar stones were discovered on the inside of the northern pier. Two of these had a pattern of three interconnected holes, each hole measuring 7 cm in diameter (Figs. 46 & 50). These were located at water level, one 19 m from the shore, at the southeastern corner, and the second another 6.5 m further to the west. The third stone with two such interconnected holes was discovered 1.2 m shorewards from the first stone. It was concluded that these may have been used as mooring holes. Due to encrustation no rope marks could be distinguished. Unfortunately, all these four stones were vandalized in our absence. This was a most disappointing and unexpected occurrence, as these superb finds had survived so many centuries. This destruction involved the breaking and removal of large ashlar stones. While taking rock samples from the bottom of the basin for chemical analysis, we realized first-hand, how very solid the rock was. This shows how determined the vandals must have been.

In order to study the foundations of the northern pier, where we expected that pottery sherds might also be discovered, we decided to remove sand from the seabed adjacent to the wall. The best device for this purpose would have been an air-lift, common in underwater excavations, or a water dredge (Green, 1990: 136). But because of our low budget, this possibility was prohibitive. Instead, we loosened the seabed cover with an improvised jetting device, using air from SCUBA tanks. It consisted of a diving regulator, a flexible hose and a 2.5 m long rigid pipe, both 8 mm in diameter. We dug-up the matter accumulated along the foundations on the outside of the northern pier, managing to reach a depth of between 15-20 cm. It was most difficult to do this work, as the gravel and stones were heavily encrusted, forming a solid body. In the removed material we discovered two pottery sherds with shallow and narrow grooves, dating from the Byzantine period 4th-6th century, (Chapt. 9). This suggests that the encrustation began forming during the Byzantine period or later.

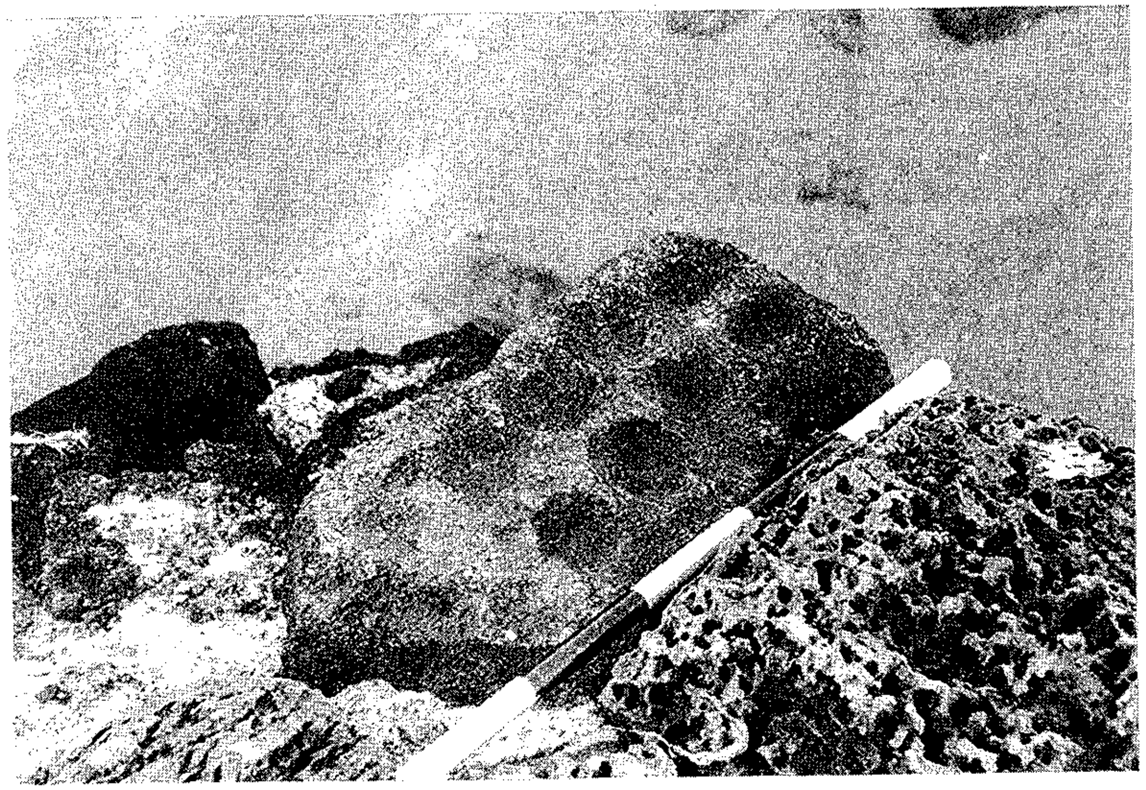

Fig. 49. Apollonia, stone with ten small recesses, in secondary use.

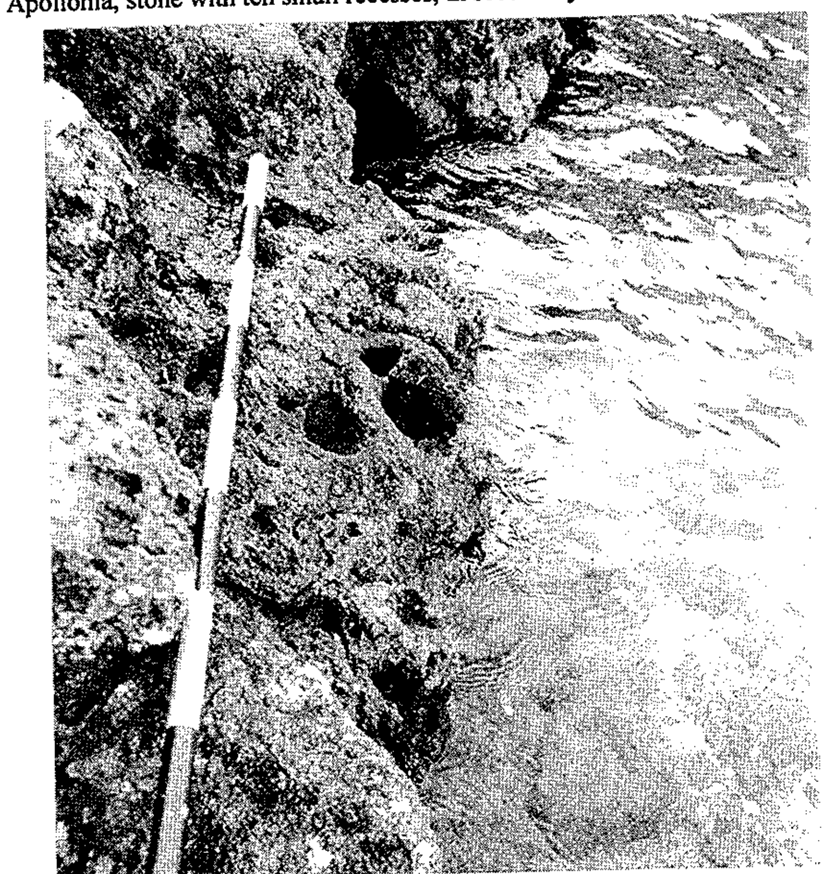

Fig. 50. Apollonia, northern pier with the mooring holes.

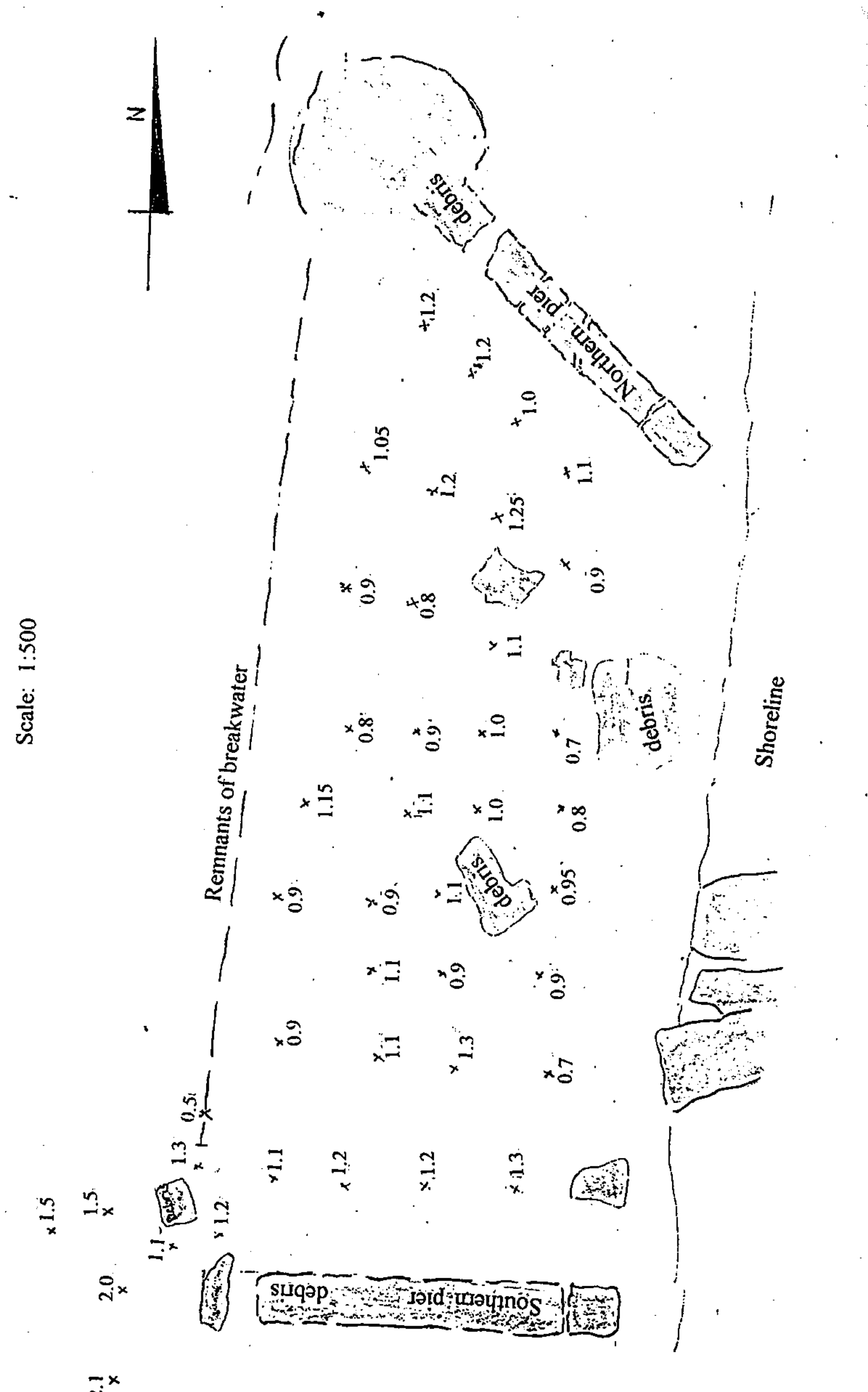

Fig. 51. Apollonia, water depth in the "Crusader Harbour".

A shallow horizontal groove was found on the inner side of the northern pier, running along the wall about 60 cm below water-level. Below the groove the stones were of a slightly larger size than above. This groove is thought to be the result of some interruption of construction work.

The southern pier has deteriorated much more, but in several locations the lower levels of stone masonry are still visible. At its western extremity lies a large block of conglomerate, part of the former tower which collapsed since 1955 when a photograph of it was taken (Fig. 5). No traces of a circular foundation for this tower, similar to the one at the northern pier, could be found.

An examination of the western breakwater revealed traces of dressing marks on the rocks which were found along its entire length, becoming more marked toward the north. A great number of scattered ashlar masonry stones were found seawards, to the west, of the structure. The breakwater is separated from the southern pier by a 10 m gap (Fig. 39).

In order to determine whether the basin was deep enough to be used as a harbour, we set out to establish its depth between the solid seabed and the zero water-level. If this basin was in fact a lower castle[1], we would have expected to find there traces of dividing walls which we did not. We set out a grid of 5-7 m squares; within the grid we probed at 38 points vertically through the sand layer, using a jetting device, until the solid rock bottom of the basin was reached. The depth was read from marks on the jetting pipe, and recorded. The jetting device performed as expected, without problems. The results are presented in Figure 51. The average depth of the basin was 1 m. Near both piers the depth to the solid rock base was 1.2-1.3 m. We assume that with a sea-level roughly 1 m higher during the Byzantine period (Figs. 10 & 11), the basin could have provided a very comfortable harbour. Even at today's water levels, if desilted, it could serve as an adequate anchorage for small fishing craft.

The opening at the southern end of the western breakwater, thought to be the harbour entrance, is today partially blocked by a wall fragment, presumably from the collapsed southern tower (mentioned above). The sea floor at the entrance and to the west of it varies in depth between 1.3 and 1.5 m beneath today's sea-level, sloping gradually into a channel running first west and changing its direction to the south. This natural channel is at least 2 m deep (Fig. 51). About 20 m to the west of the assumed harbour entrance, and beyond the mentioned channel, is a natural ridge of rock of north-south orientation which protects the entrance, but allows vessels a comfortable passage through the channel and into the open sea.

Another task was to determine whether the bottom of this basin was the natural surface, or whether the area had possibly been paved. This would provide evidence of the past use of this area as a harbour or as a building, though its function may have been changed in the course of history and with water level changes.

It was therefore necessary to gain access to the bare rock of the seabed which is covered there by a 50-60 cm thick layer of loose sand. We accomplished this by forcing a steel drum (a barrel with the top and bottom cut-off) through the sand, until its lower edge reached the solid seabed. We then removed most of the sand inside the drum manually. The last layer of sand was extracted by an improvised air lift, constructed on lines similar to the jetting tool, also with air supplied from diving cylinders. The samples of the bedrock were broken out with a crowbar and a 5 kg hammer. Two samples were taken at a distance of approximately 10 m to the south from the northern pier, one about 10 m from the shore and the second 10 m further seawards. The floor was found to be uneven and consisting of naturally occurring, undisturbed *kurkar*.

Several methods were used to try and date the "Crusader Harbour". Only two Byzantine pottery sherds were found in the basin and at the northern pier (as mentioned above), but no Crusader pottery was found. This provided us with an initial indication as to the date of the "Crusader Harbour". In addition to these finds a more definite dating scheme was required, particularly for the breakwater and piers. To this end we took samples of mortar, connecting the stones of the piers, from several locations along the northern tower and from the northern pier, the best preserved architectural feature of the site. The samples were removed from three levels, to possibly determine differences in composition and thus the periods of construction. The location of points, from where the samples were taken, is shown in Figure 52. First, three samples were removed from the base of the northern tower, some 20 cm below sea-level; one from the northern side and two about 30-35 cm apart farther to the east. More samples were taken 1.5 m above sea-level from the tower and along the northern pier, about 15-20 m from the shore. Finally, samples were removed from the uppermost parts of the structures, approximately 2 m above sea-level, from the northern tower and the pier, at a distance of about 10 m from the shore. For correlation samples were taken at several points along the basin and on top of the high tell from Crusader and Byzantine structures excavated, identified and accurately dated by Roll.

Both sets of samples were analyzed chemically by Dr. M. Katz, to establish possible differences or similarities in chemical composition. The mortar samples were gently crushed, the sand grains and other aggregates removed and the mortar, without its aggregates, examined in an atomic absorption apparatus to establish calcium-(CaO), potassium-(K_2O), and aluminium-oxide-(Al_2O_3) concentrations. The results were unequivocal. The mortar from the tower's foundation corresponded closely with the mortar from the Byzantine building, thus dating the earliest phase of the northern tower to the Byzantine period. The other mortar samples, taken from the top of the northern tower and pier, correlated closely with the comparison sample taken from the Crusader structures, indicating that when the Crusader fortress was built in the early 13th century, the northern pier was renovated. Unexpectedly, it was discovered that the composition of the mortar, removed from the uppermost sections of the northern tower and pier, suggest a second renovation during the Crusader period, likely to have

[1] According to Raban (1990: pers. comm.)

occurred when the Hospitallers took control of the fortress and revamped its defenses.

Summary results of mortar analysis

Percentage contained in mortar without sand			Description of material	Code
CaO	K_2O	Al_2O_3		
6.37	0.39	3.28	Dated Crusader mortar	X1
10.70	0.17	2.30	Dated Byzantine mortar	X2
4.74	0.53	4.26	Dated Crusader mortar	X3
			Mortar from the tower and the pier	
9.21	0.10	2.95	Tower foundation (-0.2m)*	A1
3.10	0.19	4.59	Higher level of tower (2m)	A2
6.73	0.12	4.92	Lower part of the pier (0.5m)	A4
6.90	0.46	6.23	Upper part of the pier (1.5m)	A5
3.98	0.43	5.90	Highest level of the pier (2.2m)	A6
			Mortar from different structures dated to the Crusader period	
6.22	0.73	6.88	Middle harbour, white mortar	C1
6.60	0.56	7.54	Gray-white mortar (collapsed building)	C2

* Note: measurements are reference to water-level (see text).

The above chemical compositions show a similarity between the Byzantine mortar (X2) and the mortar of the tower (A1). All the remaining samples are similar in composition to the Crusader mortar. Samples A2 and A4 contain little potash, but the content of calcium and aluminium is the same as in the Crusader mortar samples.

It is historically and archaeological documented that during the Crusader period the settlements of the inland parts of the area were slowly being abandoned and their inhabitants moved to the seashore. This happened mainly in the 13th century, when most of the Crusaders' settlements were concentrated along the sea shore and the harbour towns were fortified (Prawer, 1952: 22-25). The Crusader period was a period of political, economic and religious instability which resulted in the decline of agricultural settlements in Apollonia's vicinity, and formerly cultivated areas of the Sharon reverting to forests and swamps (Roll & Ayalon, 1989: 194). To the north of Apollonia was a large swamp named Lake Catorie (Clermont-Ganneau, 1903: 201-206). This was also mentioned by William of Tyre, when he described the conquest of Arsuf by the Crusaders in 1101 (Roll & Ayalon, 1989: 194; Willemus Tyrensis, *Chronicon* 10, 13, ed. R.B.C. Huygens: 469).

8.4 Discussion: The "Roman Anchorage"

Apollonia was a small Phoenician settlement during the Persian period (Roll & Ayalon, 1989: 24-34). The archaeological finds there do not indicate the character of this settlement at that time, but it is certain that the inhabitants were dealing and trading in purple dye produced from murex mollusc (Fig. 53). The purple trade continued on a larger scale during the Hellenistic period, and the finds of imported Hellenistic pottery point to a lively trade with the Aegean Sea.[1]

During the Hellenistic period Apollonia did not have an artificially built harbour; this is implicitly substantiated by Josephus (*Jewish Wars* I: 409), who describes the reason for building a harbour in Caesarea as being the lack of a proper harbour between Dor and Jaffa. In the Roman era Josephus mentions Apollonia as a city, a status which it seems to have inherited from the previous period (Josephus, I. 8, 166; cf. Roll & Ayalon, 1989: 23 ff). In the 2nd century AD, when most of the coast was abandoned (Roll & Ayalon, 1989: 135), Apollonia continued its urban existence. Two main north to south roads were in use for general and military purposes: one close to the coast and the other further inland (to the east), at the foot of the hill country. Ancient trade routes from inland cities as Samaria, Neapolis and from Jerusalem via Antipatris met at Apollonia (Roll & Ayalon, 1989: 236, Fig. 142; Herzog, 1989: Fig. 3.5). In the 3rd and 4th centuries AD, lateral roads leading to Apollonia began developing (Fig. 14). During that period the urban settlements in the southern Sharon were flourishing (Roll & Ayalon, 1989: 148). The great diversity of archaeological finds from eastern Mediterranean countries indicates the level of international trade. Apollonia also expanded its influence to the eastern settlements.

The town flourished during the Byzantine period. Low lying lands were drained using channels, large parts of the forests covering the Sharon Plain were cut down, and the land so obtained was cultivated. Wood, charcoal, was used as the energy source for the glass production centered in Apollonia (Gophna & Ayalon, 1989: 25) (Figs. 74 & 76.5).

With all the development and expansion occurring during the Byzantine period, there arose a necessity for a harbour to accommodate the corresponding increase in sea trade. A harbour or anchorage is the connecting element of the political, social and economic needs and aspiration of the inhabitants (Scoufopoulos *et al.*, 1975: 103). Those who directed and governed had to consider international trade and the needs of the hinterland if they wanted further development. This is true for large, as well as small harbours. For the mariners sailing the rough seas, a harbour brings release from tension, and as a mosaic at Ostia poignantly puts it: "the harbour where ends all pain" (Rickman, 1988: 257-265).

The excavations at Apollonia by Roll and Ayalon revealed the regional importance of the industrial town during the Late Roman and Byzantine period (Roll & Ayalon, 1989: 38-67). The evidence of glass, wine and purple dye industries, and the diversity of imported vessels which were found at the site, confirm the writings of Josephus (Jos. *Ant.* I, paragraph 8, 166), Pliny (Plin. NH V, 14, 69) and others, who mention Apollonia among the important towns on the coastal plain. The finds connect Apollonia also to the north, with which it must have conducted active trade.

[1] For a detailed discussion on this subject see Karmon 1999: 273-280.

This is indicated by the many ballast stones in Area D and the remnants of wood recovered from anchor No. 21 from Area B-C, the origin of which would have been in Anatolia (Figs. 89.21 & 90, Grossmann & Kingsley, 1996: 49-54). The connection to Anatolia is supported by excavations on land, where a small burial stela was found (Roll 1993, pers. comm.). A parallel relief, of the same mourner's meal offerings, appears in a larger version on the Satrapen sarcophagus from Kyzikos, Turkey, of the 4th century BC. (Akurgal, 1987: Pl. 116).

It is obvious that as an important coastal center of the Sharon Plain, the city would also have needed an improved and well developed port, rather than a natural anchorage among the coastal rocks between the "Roman Anchorage" and the "Crusader Harbour", as was suggested by Raban and Roll (mentioned above). This natural bay is still used today by local fishermen to moor their boats. These modern fishing vessels are small and light and are easily carried onto the beach and up the hill to safety during rough seas. This was certainly not the case with international traders in the past, whose boats were heavy and risked hull damage if beached.

To the south of the town of Apollonia, a modern stairway descends to the seashore. We began this study by assuming that in ancient times this was the location of a natural ramp, possibly providing maritime traders with convenient access to the shore. It was at the base of this "ramp", that we began our search for the "Roman Anchorage" a logical location for the site of a harbour/anchorage. Presently it is a bay, protected by rocks from the west and north, with a wide opening to the south (Figs. 4 & 38). These naturally occurring rocks probably served as the foundation of a massive breakwater (Area D). Many ashlar stones, pillars and storage jars were discovered near the shore. The architectural remnants are likely to have been parts of warehouses and other facilities, providing the usual harbour services (Area B). Area C, closed to the north and west, being clear of obstacles and ranging in depth from 1.8-2 m provided an anchorage. Based on the concentration of ashlar stones present (scattered over a distance of about 50 m east to west), we believe that the massive structure of Area D served as an artificial breakwater and quay, possibly 20 m in width, with facilities for the mooring, loading and unloading of ships. It is believed that this site represented an important harbour, equipped with all the necessary maritime facilities, including storehouses and a wide breakwater.

8.5 Discussion: "Crusader Harbour"

Beneath the Crusader fortress at Apollonia lies a basin (Figs. 6 & 39). Considering this configuration, previous researchers assumed that this was a harbour built by the Crusaders. However, evidence presented herein contradicts this conclusion. The results of mortar analyses and the two pottery sherds found at the site support the conclusion that the harbour was initially built during the Byzantine period, and twice fortified during the Crusader period.

Also the survey of the basin supports the conclusion that it was built in the Byzantine period, when the sea level was approximately 1 m higher, in line with the findings of Nir & Eldar (1987) and Raban (1985), described above. From the jetting survey conducted, it was found that the solid floor of the basin lies between 0.8 and 1.3 m under the present day sea level (Fig. 51). This means that in the Byzantine period the depth of the basin was roughly 2 m, sufficient to accommodate boats of a size corresponding to the possibilities of approach and the dimensions of this harbour.

In line with the supposed lower sea level during the Crusader period, Raban has suggested that the "Crusader Harbour" was built by the Crusaders as a lower fortress, and was never used as an anchorage. According to Raban, the presence of dividing walls was to be expected in the basin. However during the systematic survey of the entire basin no dividing walls were detected nor any find that would indicate that such structures existed there. Furthermore, should the basin have been a lower fortress, it would surely have been protected all around its perimeter. The wide gap in the breakwater which we believe to have been the harbour entrance, would not have existed. Therefore the assumption that this was a lower fortress during the Crusader period can now be ruled out.

Evidence suggests that the "Crusader Harbour" was built in the Byzantine era. Encrusted pottery sherds found, while jetting at the northern pier's foundations, and mortar samples taken from the base of the northern pier, have been dated to the Byzantine period. Other mortar samples indicate a renovation of the piers, when the Crusader fortress was built in the early 13th century; and mortar analyses indicate and confirm Crusader documents that when the Hospitallers were in control of the fortress and renovated its defenses, they may have again renewed the harbour (Roll & Ayalon, 1989: 114-116).

A point of interest about the layout of the "Crusader Harbour" is its entrance (Fig. 6, 39 & 51) which appears to be at the "wrong" end and would not allow self-dredging of the port by the effect of longshore currents. As it happens, the nodal point, which today is located between Netanya and Apollonia, causes the longshore current to flow north to south, contrary to its typical direction, as discussed above (Chapt. 2). The heavy build-up of sand, immediately north of the "Crusader Harbour" recorded on the British *SWP* map of Conder & Kitchener, provides evidence for this phenomenon (Fig. 6). Also the present day polluted waters spilling into the sea north of the "Crusader Harbour" also flow to the south (Fig. 47). The vertical gaps in the northern pier permit the flow of substantial quantities of water for desilting, as previously discussed.

During the Crusader period, Apollonia was the only port city of the southern Sharon, and acted as an administrative center. The "Crusader Harbour" was likely to have been used by the Crusaders during their control of the site, an assertion supported by its extensive fortifications. Whether the Crusaders used the basin as an anchorage or not remains to be answered. However, it would seem illogical for their having renovated these structures, yet never actually using the harbour, especially when one considers that shipping was he lifeline connecting them to their supply and power bases in Europe.

8.6 Conclusion

On evaluating the evidence collected to date, it would seem that both the "Roman Anchorage" and the "Crusader Harbour" were built during the Byzantine period. The "Roman Anchorage" most probably served as an *emporion* for international trade, and the "Crusader Harbour" as a *neorion* for local activities.

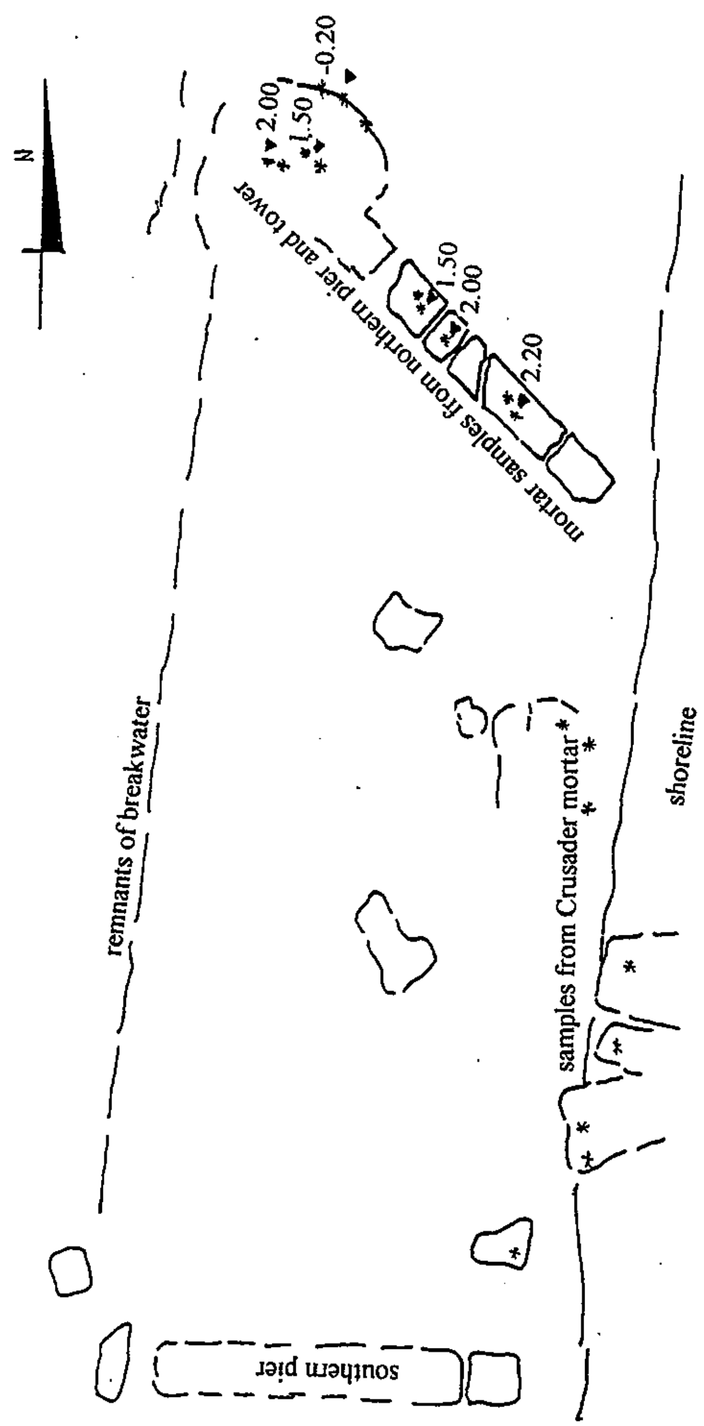

Fig. 52. Apollonia, "Crusader Harbour" – points from where mortar samples were taken.

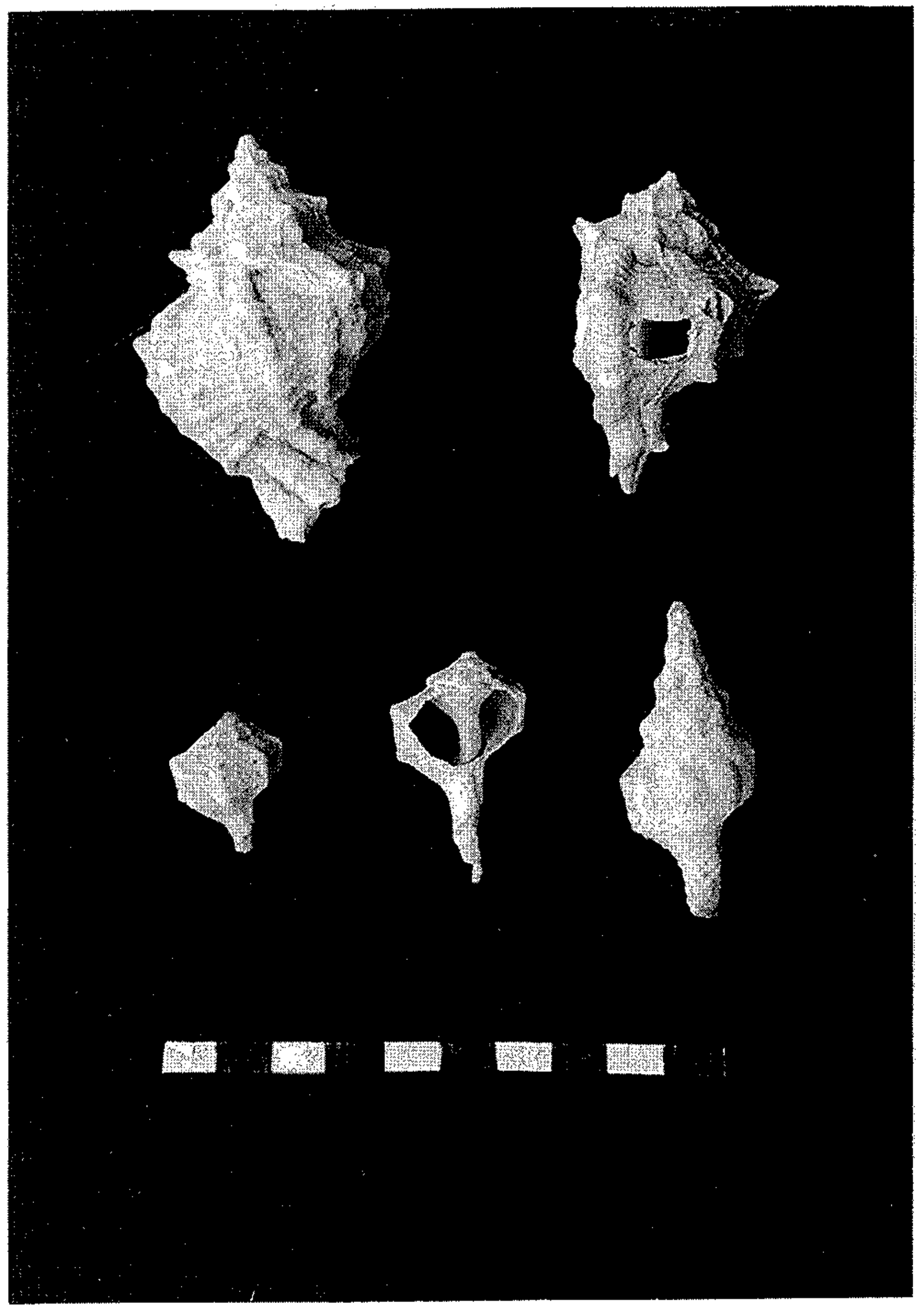

Fig. 53. Murex mullusc.

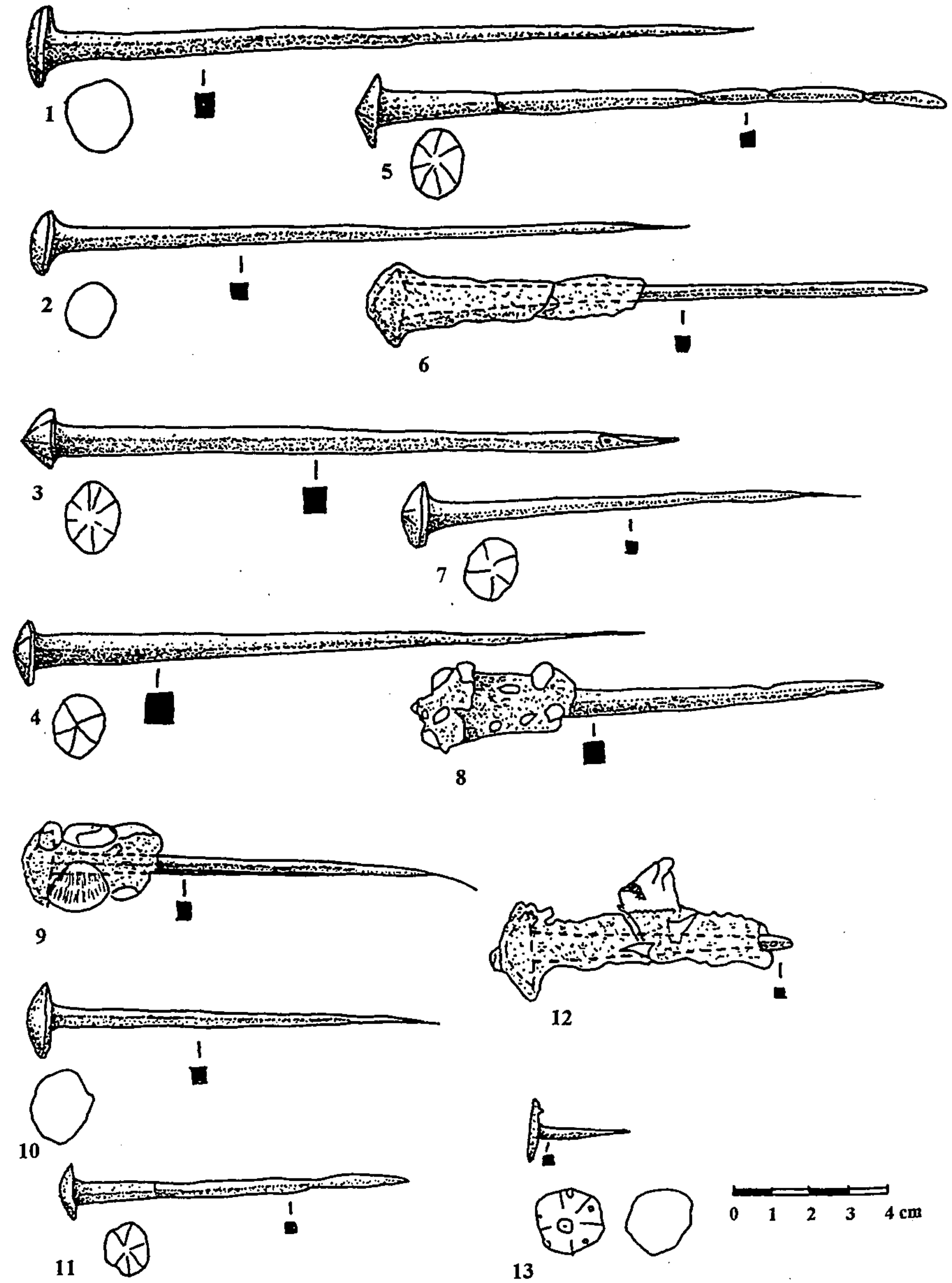

Fig. 80. Copper nails (Fig. 81).

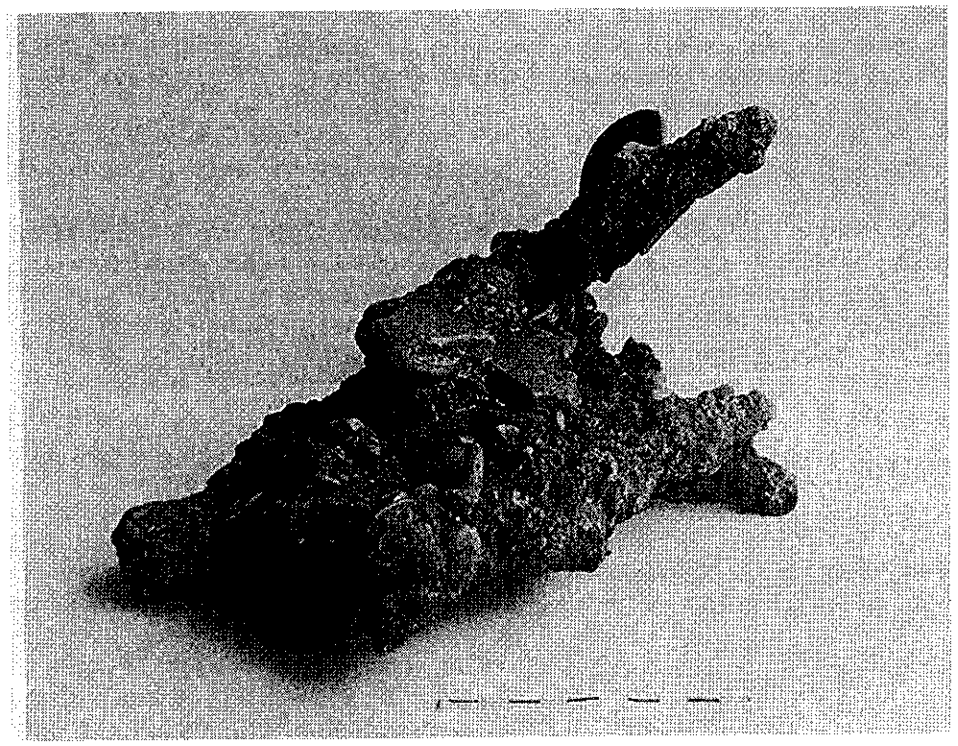

Fig. 81. Copper nails with heavy encrustation, as removed from the seabed.

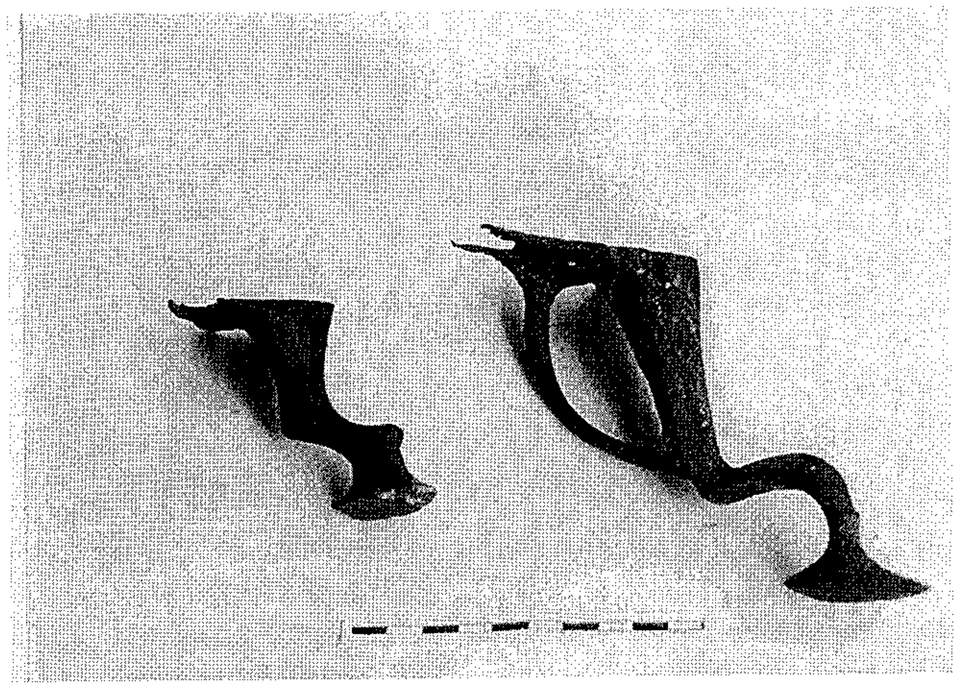

Fig. 82. Two copper legs (Fig. 83.1 & 2).

6. An iron arm from a Byzantine anchor; preserved length is 67 cm. Its section is square. The anchor's shank, although recorded, was not retrieved. When located, the arm was thickly encrusted. The iron shank was found several metres away from the arm, and has a ring at one end. It is assumed that both probably belong to the same anchor. Both were photographed *in situ*. The arm was removed. Area E. (Inv. No. (97.91) 10.1; [I-6445 1992-1344]).

Parallels: this anchor type has been discussed by Kapitän (1984: 42-43 & fig. 8/D), and comparable examples were excavated on the Byzantine shipwreck at Yassi Ada (Bass, 1962: 542-546; 1966: 143-161; 1982: 155-188). Similar anchors were common at Dor, including small examples (Raveh and Kingsley, 1991: 198, 61, FE 3, fig. 41 & pl. 57 and p. 23, MA 12, fig. 20 & pl. 18).

7. A lead ring, 4 cm in diameter. Area B. (Inv. No. (35.92) 20.4; [I-6445 1992-1328]).

8. A flint flake without retouch found at Tel Michal on the eastern side of the submerged ridge. There are no signs of gloss adhering.

Fig. 82 & 83

1-2. Two copper legs were found east of Area E and probably represent part of a bowl. They are 6.5 cm and 9.5 cm high. (Inv. No. (6.90) 6.2 I; [I-6445 1992-1349]. Inv. No. (6/90) 6/2 II).

Parallels: Turquety-Pariset (1977: 52 & figs. 14/105 & 106).

3. A copper strip, 2 to 3 mm wide and 17 cm long. It have been part of a *strigil* used to remove fatty ointments from the skin. Located between Areas B and C. (Inv. No. (97.91) 15.5 [I-6445 1992-1338]).

Fig. 65

A number of copper nails of various lengths were found. The entire collection was unused: the heads and tips were intact and unblemished, and many tips remained needle-sharp. The nails were found in encrusted clusters, completely covered with shells and small pebbles. When the encrustation was broken, the nails proved to be in an excellent state of preservation. Their lengths varied from 2-18 cm. The smallest, (No. 13) resembles a thumbtack (with knobs attached to the bottom of the head to prevent sliding). Most of them have needle shaped extensions on their tips, possibly used to guide the nail precisely into the wood. Area E. (Inv. No. (6.90) 6.3; [I-6445 1992-1350]).

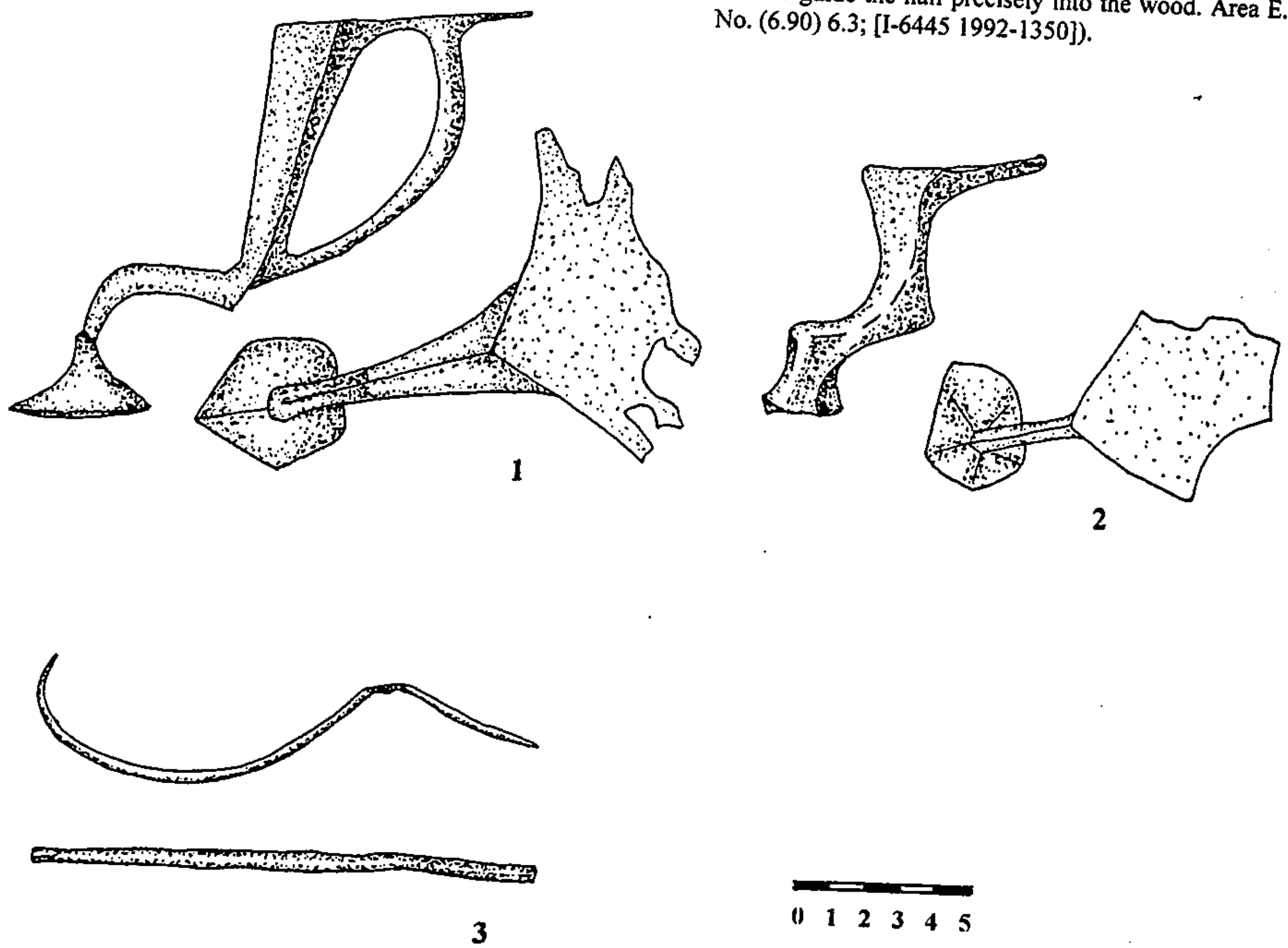

Fig. 83. Copper objects. No. 1 & 2 two copper legs, No. 3 a copper strip, *strigil*. Scale 1:1.

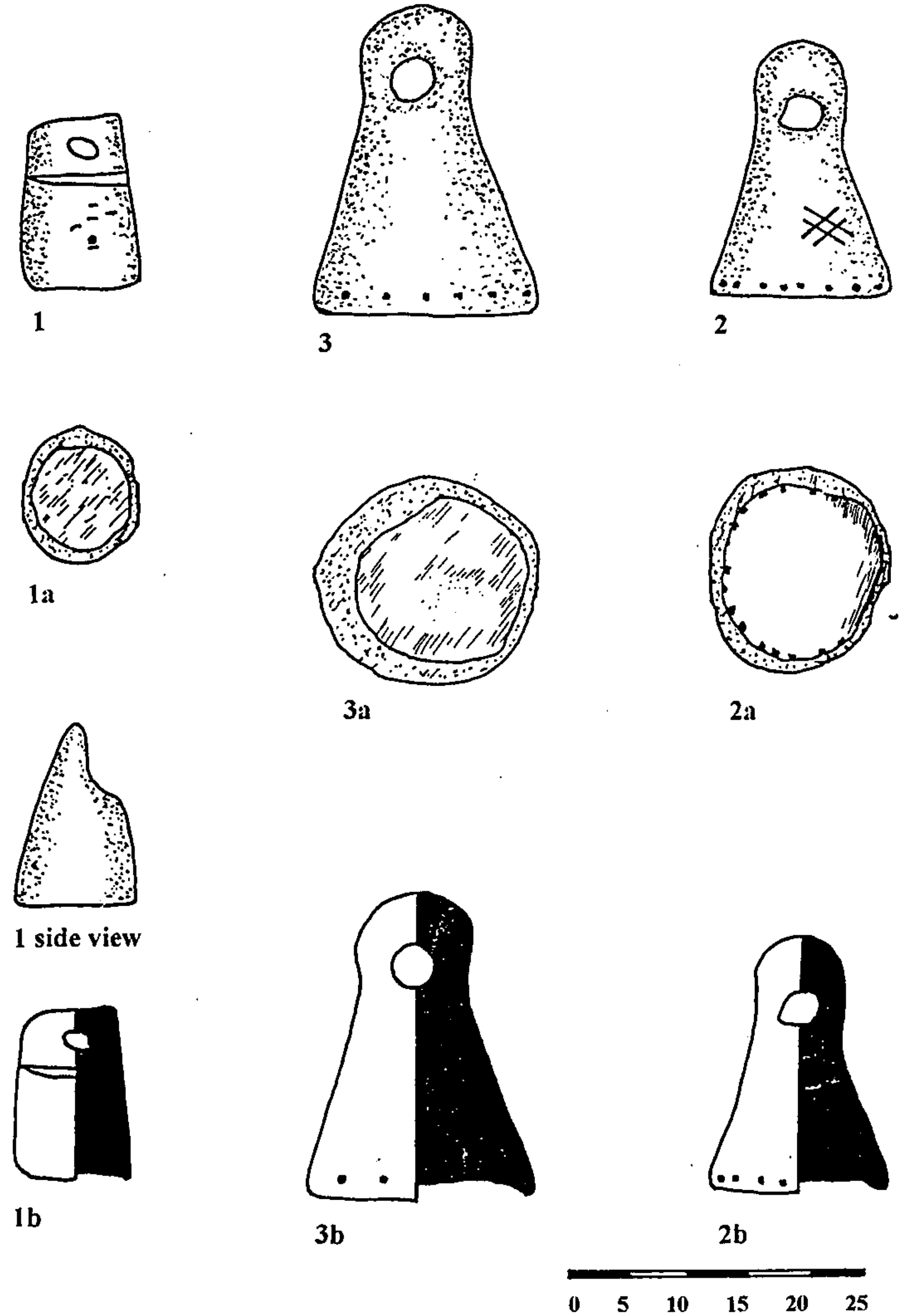

Fig. 84. Sounding leads.