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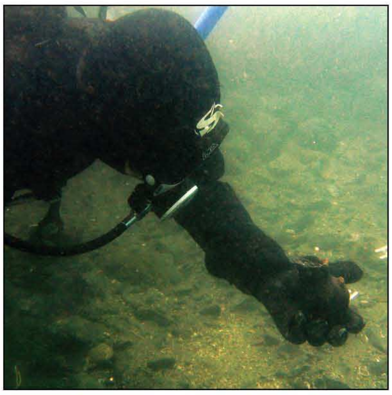

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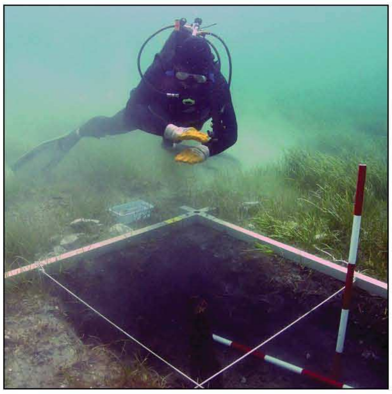

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Submerged Neolithic Settlements off the Carmel Coast, Israel: cultural and environmental insights

Ehud Galili and Baruch Rosen

Inundated Neolithic settlements, dated to 7200 to 6000 cal BC, were exposed off the Carmel coast of Israel as a result of erosion. The late Pre-Pottery Neolithic (PPNC) village of Atlit-Yam revealed human burials, rectangular stone structures, megalithic structures, and stone-built water wells. Subsistence was based on a combination of agro-pastoral activity and marine resource exploitation. Hunting continued together with herding of domesticated sheep and goats and incipient herding of cattle on the verge of domestication. The development of wells that utilized coastal aquifers enabled permanent human habitation near the coastline for the first time in this area. The later Pottery Neolithic (PN Wadi Rabah Culture) sites revealed olive oil extraction installations and water wells constructed of wood and stones. At the Neve-Yam PN site, human skeletons were discovered in stone graves. The PN sites demonstrate a fully agricultural subsistence economy. The submerged Carmel coast sites demonstrate the emergence of the Mediterranean fishing village on the south Levant coast. The emergence of the separate burial ground at Neve-Yam and the question of the separation of the living from the dead is discussed and explained. The beginning of olive oil extraction, a major component of the Mediterranean subsistence, is demonstrated at Kfar Samir. The earliest known case of tuberculosis is reported from Atlit-Yam.

Keywords: underwater archaeology, PPNC, Wadi Rabah, burials, water wells, olive oil, Mediterranean diet, fishing village, sea-level rise

Introduction

Postglacial sea-level rise inundated prehistoric settlements situated near ancient coastlines. Remnants of such settlements, dated to the Neolithic period *c*. 7200–6000 cal BC, have been found underwater off the Israeli Carmel coast (Fig. 22.1). They belong to two chronological entities: the Late Pre-Pottery Neolithic (PPNC) *c*. 7200–6300 cal BC, and the Late Pottery Neolithic (PN, Wadi Rabah Culture) *c*. 6000–4700 cal BC, and they were uncovered as a result of intensive sand quarrying and construction of marine structures. Underwater archaeological surveys and excavations have enabled a reconstruction of the material culture and the socio-economic system of the Neolithic inhabitants of the Levantine coastal plain. Additionally, they made it possible to reconstruct the palaeoenvironment and study its impact on coastal habitations during this important period in the development of Neolithic lifeways in the Old World.

The Atlit-Yam PPNC submerged village thrived from *c*. 7200 to 6500 cal BC. It is located in the north bay of Atlit, submerged at a depth of 8–12 m, and extends over approximately 40,000 m^2 (Fig. 22.2). Excavations revealed foundations of rectangular stone structures, round installations, a monumental structure built of sandstone megaliths (Fig. 22.2, structure 56; Fig. 22.3), anthropomorphic stone stelae,

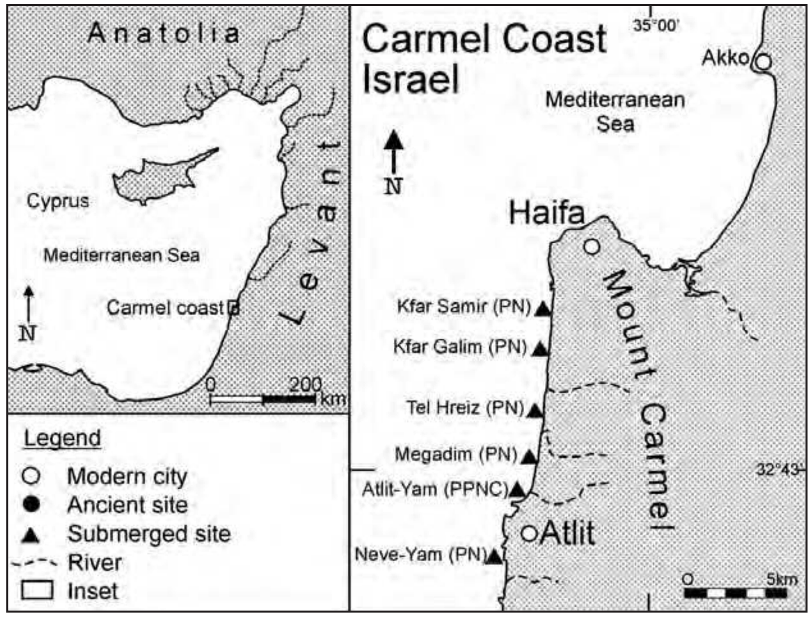

Figure 22.1: The Carmel coast and submerged prehistoric sites referred to in the text

stone-built water wells (Figs 22.4–6), and some 35 hearths with associated charcoal remains. The tools found were made of stone, bone, and flint, and include axes, spearheads, sickle blades, and arrowheads. Sixty-five human skeletons buried in flexed (foetal) positions were also uncovered (Fig. 22.7) in and around the structures. Organic remains include animal and fish bones, numerous charred and waterlogged seeds, tree branches, and pollen. The organic remains suggest that the village's economy was complex, based on hunting, herding, fishing, and farming (Galili *et al.* 1993, 2004).

Numerous Pottery Neolithic remains were revealed in a narrow, almost continuous distribution zone: a submerged belt *c.* 15 km long and 200 m wide, which runs parallel to the modern shoreline of the north Carmel coast. It includes five PN sites dated approximately to the 6th millennium cal BC, all situated at water depths of 1–5 m (Fig. 22.1) (Wreschner 1977a, 1977b, 1983; Galili and Weinstein-Evron 1985; Galili *et al.* 1989, 1998; Horwitz *et al.* 2002, 2006). In these sites, stone- and wood-built structures were found, as were numerous stone, flint, bone, and pottery artefacts. Stone-built graves containing human skeletons were also discovered (at Neve-Yam), as were various types of installations and pits, some of which contained charred and waterlogged plant remains and animal bones. Excavations and surveys at Kfar Samir and Kfar Galim revealed paved floors, olive oil extraction installations (Galili and Weinstein-Evron 1985; Galili *et al.* 1997), and several wells constructed of alternating layers of branches and stones (Fig. 22.8; Galili and Weinstein-Evron 1985). Additionally, round pits containing plant remains (mainly broken olive stones and pulp)

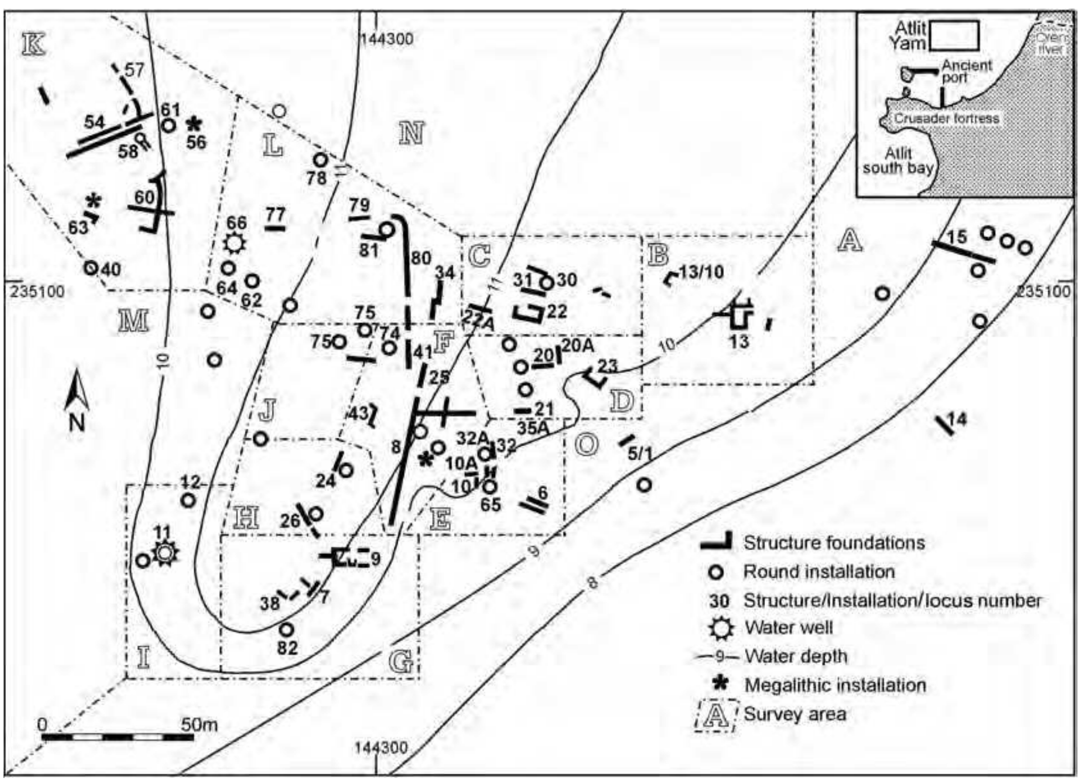

Figure 22.2: Plan of the Atlit-Yam PPNC site and location of installations mentioned in the text

Figure 22.3: The megalithic structure at Atlit-Yam: Top: measuring the structure. Bottom: excavating the adjacent seabed (Photos: Itamar Greenberg)

Figure 22.4: Atlit-Yam water well no. 11 during excavation (Photo: Itamar Greenberg)

were found together with wooden bowls (Fig. 22.9), fragments of woven reed mats, and stone basins (Fig. 22.10).

The water wells of Atlit-Yam

At Atlit-Yam, about 30 round stone features, each with a diameter between 0.8 m and 1.5 m, were identified, and two were excavated (Fig. 22.2: structures 11 and 66). Structure no. 11 (a well) was excavated down to its bottom, 5.5 m below the present seafloor and 15.5 m below the present sea level. The other well (no. 66) was partly excavated to a depth of about 1 m. Other (unexcavated) round structures in the site probably also served as water wells and storage pits (Galili and Nir 1993; Galili 2004).

Well no. 11 was cylindrical, 5.5 m deep and 1.5 m in diameter (Figs 22.4 and 22.5). Its upper section was built in undressed stone. Three courses had survived *in situ* above the present seafloor forming a wall (0.7 m high) that circled the open shaft and prevented the introduction of foreign objects. The uppermost 3.6 m of the well were dug into clay sediments and surrounded by 22–25 courses of stones. The number of stones in each course varied between 14 and 24. The lower section, 3.60–5.15 m below the site surface, was excavated into carbonate-cemented quartz sandstone ('kukar').

The fill of well no. 11 was excavated by a dredging system and underwent a series of wet and dry sieving (Galili and Nir 1993; Galili 2004). It presents a complex multi-layered deposit, which can be divided into three main sedimentation phases. The upper phase was composed of small and medium (3–15 cm) undressed kurkar stones and broken limestone pebbles, most showing signs of exposure to significant heat. This phase also contained carbonate sand composed of crushed shells and whole mollusc valves (*Glycimeris* sp.) – all probably late intrusions.

The middle phase extended from just below the previous land surface down 2.10 m. It contained animal bones (few in partial articulation), waterlogged and charred plant remains, and hundreds of flint, stone and bone artefacts, and waste from flint working. The fill was composed mainly of soft clay, small and medium sized stones, with some quartz and carbonate sand present. Lenses of very fine, soft

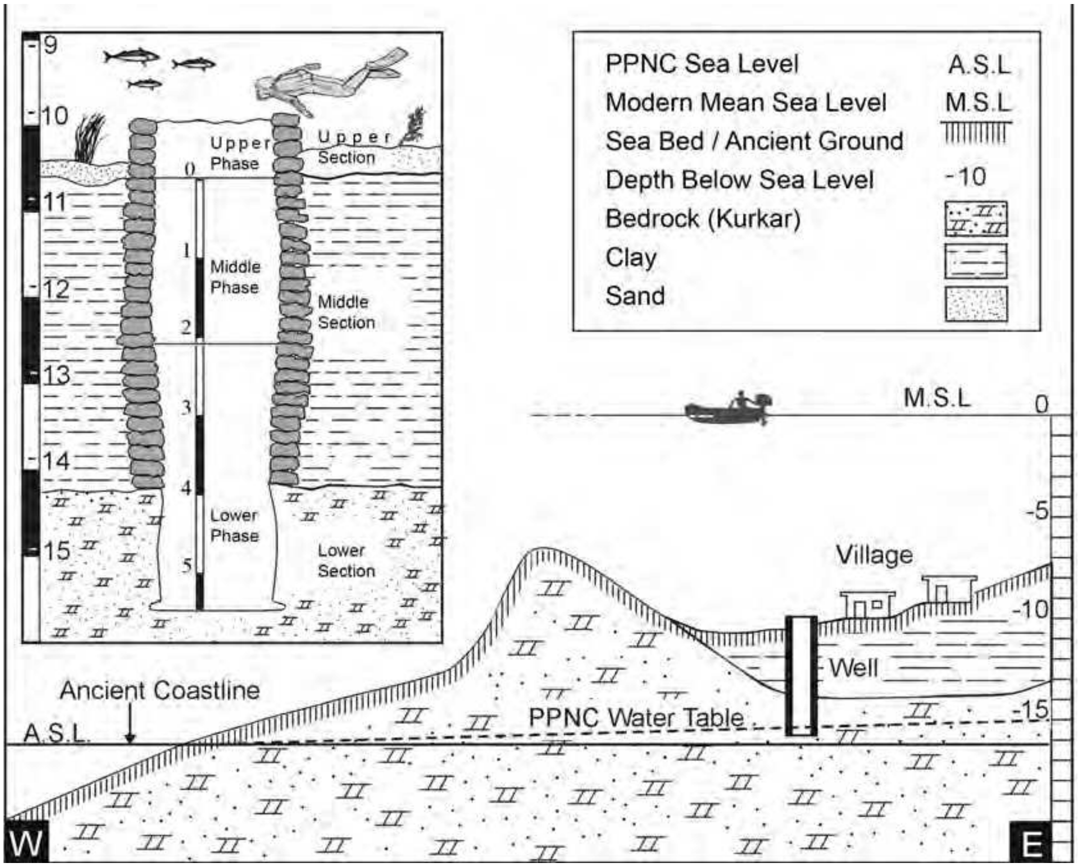

Figure 22.5: Cross-section of Atlit-Yam well no. 11 and schematic reconstruction of the topography and sea level at the site during PPNC

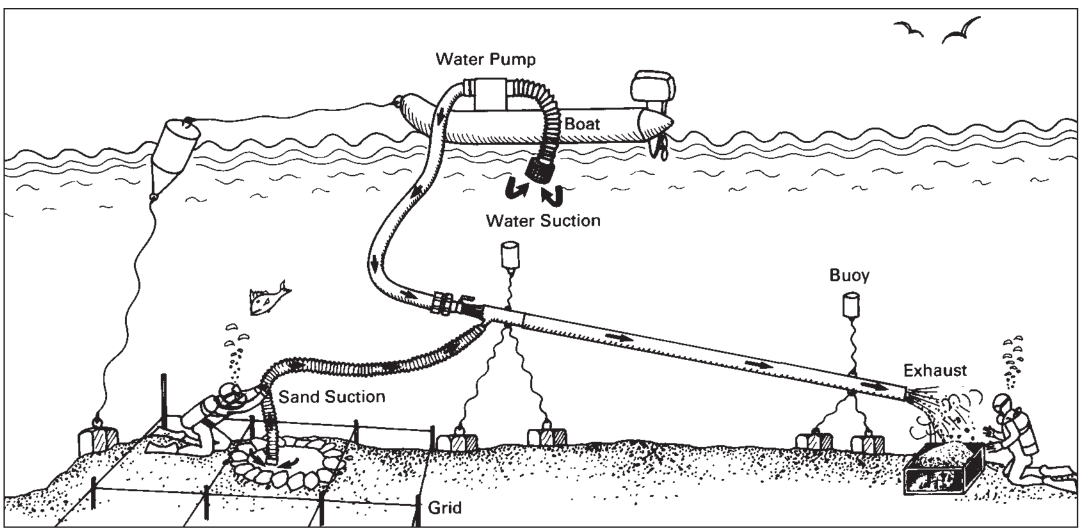

Figure 22.6: Excavation methods of the Atlit-Yam wells

Figure 22.7: Skeleton of a young woman buried in a flexed position at the Atlit-Yam site (Photo: Ahuva Zaid)

Table 22.1: Radiocarbon dates from the submerged settlements off the Carmel coast: RT = Weitzman Institute, Israel (Carmi and Segal 1996; E. Boaretto, pers. comm.); PITT = Pittsburgh, USA; PTA = Pretoria, South Africa, Beta = Beta Analytic Inc., Miami, Florida, HV = Hanover Radiation Laboratories USA. Calibrations performed using OxCal v4.1.7 (Bronk Ramsey 2009) and the IntCal09 dataset (Reimer et al. *2009)*

Material dated and context	Lab. ref.	Uncalibrated ^{14}C age BP	Calibrated age BC (2σ)
Atlit-Yam			
Charcoal, structure 13	PTA-3950	8000±90	7165–6649
Charcoal, structure 13	RT-707	8140±90	7453–6826
Charcoal, structure 10A	RT-944A	7670±85	6680–6390
Charcoal, structure 10A	RT-944C	7610±90	6641–6256
Charcoal, structure 10A	PITT 0622	7550±80	6568–6237
Wood, well 11	RT-1431	7300±120	6425–5984
Wood, well 11	RT-2479	7460±55	6431–6232
Wood, well 11	RT-2477, 2478	7605±55	6591–6387
Wood, well 11	RT-2475	7465±50	6427–6238
Wood, well 66	RT-2495, 2493	7755±55	6679–6471
Wood, well 66	RT-2489	7880±55	7029–6606
Charcoal, structure 32	RT-2681	6580±35	5615–5478
Charcoal, structure 54	RT-3038	8000±45	7061–6709
Charcoal, structure 56	RT-3043	7250±45	6220–6030
Charcoal, structure 65	RT-2497, 2496	8170±55	7333–7058
Neve Yam			
Charcoal, centre of site – dwellings	HV-4256	6310±395	6003–4373
Charcoal, south side – cemetery	RT-1723	6390±70	5481–5223
Charcoal, south side – cemetery	RT-1724	6565±70	5630–5376
Kfar Samir			
Wood, well 113	Beta-82851	5860±140	5198–4373
Wood, well 5	RT-682B	6470±130	5664–5081
Wood, well 3	RT-682A	6670±160	5898–5318
Wood, well 5	PTA-3820	6830±80	5895–5570
Wood, well 3	PTA-3821	6830±160	6015–5482
Wood, pit 10	Beta-82850	6940±60	5981–5718
Olive pit, installation 6	Beta-82845	6080±70	5213–4810
Olive pit, installation 6	Beta-82846	6210±150	5476–4801
Olive pit, installation 6	Beta-82847	6210±80	5341–4947
Olive pit, installation 6	Beta-82848	6230±80	5370–4965
Olive pit, installation 6	Beta-82715	6500±70	5611–5324
Olive pit, installation 6	RT-1898	5790±55	4781–4505
Olive pit, installation 6	RT-1930	5870±70	4929–4548
Olive pit, installation 7	Beta-82843	6100±60	5213–4849
Olive pit, installation 7	Beta-82844	6290±60	5465–5064
Olive pit, installation 7	RT-1929A	5630±55	4584–4350
Olive pit, installation 7	RT-1929	5870±70	4929–4548
Wood, installation 9	Beta-82849	6350±90	5484–5071
Mat fragment, installation 8	RT-855	6420±120	5620–5078
Wooden bowl	RT-1360	7230±80	6327–5923
Tel Hreiz			
Wooden fence	RT-779A	7330±120	6430–6003
Wooden fence	PTA-3460	6310±70	5470–5076
Wooden fence	RT-779B	6260±150	5508–4842
Wooden fence	RT-2480	6150±30	5211–5008
Megadim			
Clay	PTA-3652	7960±70	7056–6661

Material dated and context	Lab. ref.	Uncalibrated ^{14}C age BP	Calibrated age BC (2σ)
Bone	PTA-3648A	6310±70	5470–5076
Bone	PTA-4339A	6270±50	5358–5069
Kfar Galim			
Wooden structure – well	RT-1748	5985±70	5052–4713
Wooden structure – well	RT-1749	5985±55	5001–4726
North Kfar Galim			
Branch	RT-1750	6890±50	5887–5673

clay were attached to the walls. There were two clear layers of medium to large (15–30 cm long) stones embedded at 90–110 cm and 180–200 cm respectively below the former land surface. Traces of gypsum, found *c.* 80 cm below site surface, testified to high-salinity conditions. Around 180–210 cm below site surface numerous land snails were found.

The lower phase, 200–500 cm below surface, contained kurkar stones of various sizes embedded in sandy clay, various flint, bone, and stone artefacts, and a few animal bones and sediments typical of coastal water wells (Nir and Eldar-Nir 1986, 1987, 1988; Galili and Nir 1993). Three ^{14}C dates on wood (Table 22.1: RT-2475, RT-2477/78 and RT-2479) from this lowest section, have a 2σ calibrated age range of 6450–6250 cal BC after averaging (cf. Galili 2004; E. Boaretto, pers. comm. 2005).

Relative to the central phase, the lower phase of the well contained more plant materials. In striking contrast to the lower section of the well, there were hundreds of animal bones in the central section, undoubtedly representing discarded consumption debris deposited in a well that was no longer in use. Materials in those layers were typical of refuse associated with human habitation. Stone tools recovered from the upper section of the well were mostly broken and some of the stone bowl fragments show signs of mending (by piercing and sawing) or reuse (by flaking and turning them to scrapers). In the lower section, ornaments and decorated artefacts were found and only a few broken tools were present.

The presence of few articulated bones in well no. 11 indicates a deposition where the bones were still combined with soft tissue. It is unlikely that people would pollute their primary freshwater source with such waste. It is however likely that the well ceased to be productive because of seawater seepage due to continuous sea-level rise (Galili *et al.* 1993; Galili and Nir 1993). The presence of gypsum, indicative of high salinity, supports this proposition. The layers of large stones may be seen as attempts at heightening the bottom of the well for the purpose of obtaining water from higher aquifer levels.

Well no. 66 was dug into layers of clay. One course of undressed stones survived above the surface. The circular feature was 110 cm in diameter and the fill contained soft clay with hundreds of small and medium size stones. Faunal remains included *c.* 400 bones of herbivores, carnivores, rodents, reptiles, and fish. Few human bones were found. Artefacts made of flint, stone and bone were also recovered, and it is noteworthy that most of them were broken.

Re-use of excavated shafts and abandoned wells as garbage pits can be seen in other prehistoric sites, including Mylouthkia on Cyprus (Peltenburg *et al.* 2001), Sha´ar Hagolan in Israel (Garfinkel *et al.* 2005), and in Europe (e.g. Weiner 1998).

The PN water wells

PN water wells constructed of wood and limestone were found at the Kfar Samir and Kfar Galim sites. In Kfar Samir one such well was excavated to a depth of 2 m below the seabed (Fig. 22.8), at which depth its bottom was not

Figure 22.8: The well at Kfar Samir (Photo: Ehud Galili)

Figure 22.9: Wooden bowl uncovered at the Kfar Samir site (Photo: Josef Galili)

reached. The well had a 100 × 80 cm rectangular opening, and was built of alternating courses of branches and limestone. In its lower parts, two courses of stone were laid between the horizontal wooden construction elements. The fill consisted of soft clay with small pieces of stone, bird bones, olive stones, ceramic fragments, and flint flakes. It also included straw fragments, which were probably the remains of a mat.

Dating the water wells

Atlit-Yam was dated by ^{14}C analysis of charcoal from hearths and wooden remains from the fill of wells (Table 22.1). The dates of the wells' fills are slightly later than the dates of the hearths' charcoal. The wells were probably dug and constructed during the early stage of the village. The relatively late dates from the well are probably due to cleaning activities, which removed earlier deposits. The dates of the PN Kfar Galim and Kfar Samir wells are more representative as they were obtained from materials used in laying the walls of the wells.

Sustainable freshwater supply: a pre-condition for permanent coastal settlement

Freshwater availability is essential for humans and their livestock. In early prehistory only limited quantities of drinking water could be transported long distances. Nonetheless, a dramatic increase in human need for water took place with domestication and the introduction of husbandry. In the arid and semi-arid Israeli coastal plain, the availability of drinking water is a continuous problem in sedentarization. Shortage of perennial water sources made extensive areas uninhabitable. Throughout

Figure 22.10: Diver examining a stone basin that may have been used for crushing olives at the Kfar Samir site (Photo: Ehud Galili)

history, humans developed methods of procuring and storing water by constructing reservoirs, cisterns, canals, and wells. Water wells, unlike cisterns, generally provide high discharge and a permanent water source.

There is a paucity of information concerning well evolution in the Levant, and among the few known are: the PN unlined wells at Lemba, Cyprus (Peltenburg *et al*. 2001), the Sha'ar Hagolan stone-walled Yarmukian well (Garfinkel *et al*. 2005), the Late Neolithic well at Hacılar (layer VI, *c*. 5500–5400 cal BC) in southwestern Anatolia (Mellaart 1961), the Chalcolithic wells at Abu Hof (*c*. 4000–3200 cal BC) in the Israeli Negev (Alon 1988), and in Rajajil (*c*. 4000–3200 cal BC), north Arabia (Zarins 1979). By the Middle Bronze Age (*c*. 2200 cal BC) wells had become widespread and usually consisted of a round structure built of cut stones (Nir and Eldar-Nir 1986, 1987, 1988).

In an area rich in economic resources, but lacking fresh water, establishing wells is rewarding. Wells allow for the development and occupation of new territories. Wells increase carrying capacity of an area where water is a limiting factor. Thus, water well installation in the south Levant may be related to a terminal PPNB attempt to cope with shrinking environmental resources and to occupy new or previously underutilized areas. Parts of the Israeli coastal plain are situated above a high freshwater aquifer, which, given adequate technology, can be exploited year-round. Therefore, the early emergence of well digging in this region should not come as a surprise. Wells appeared much later in other areas of Western Asia such as the arid Saharo-Arabian and semi-arid Irano-Turanean inland Mediterranean climatic zones, or areas adjacent to rivers, deltas, or lakes.

It is likely that rapid changes in river courses and water availability in the southern Levant necessitated constant pursuits for freshwater sources (Tsuk 2000: 44). Such pursuits encouraged inhabitants to adapt and learn that water can be found underground. Thus, well-digging technology may have evolved in the PPNB when a need or decision to settle new territories arose. Creating a sustainable freshwater source on the coast enabled the establishment of permanent settlements, and this may then be closely associated with the emergence of Mediterranean fishing villages on coasts that lacked a visible surface freshwater supply.

Coastal wells and sea-level changes

The Pleistocene coastal aquifer of Israel drains westward toward the Mediterranean. A rise in

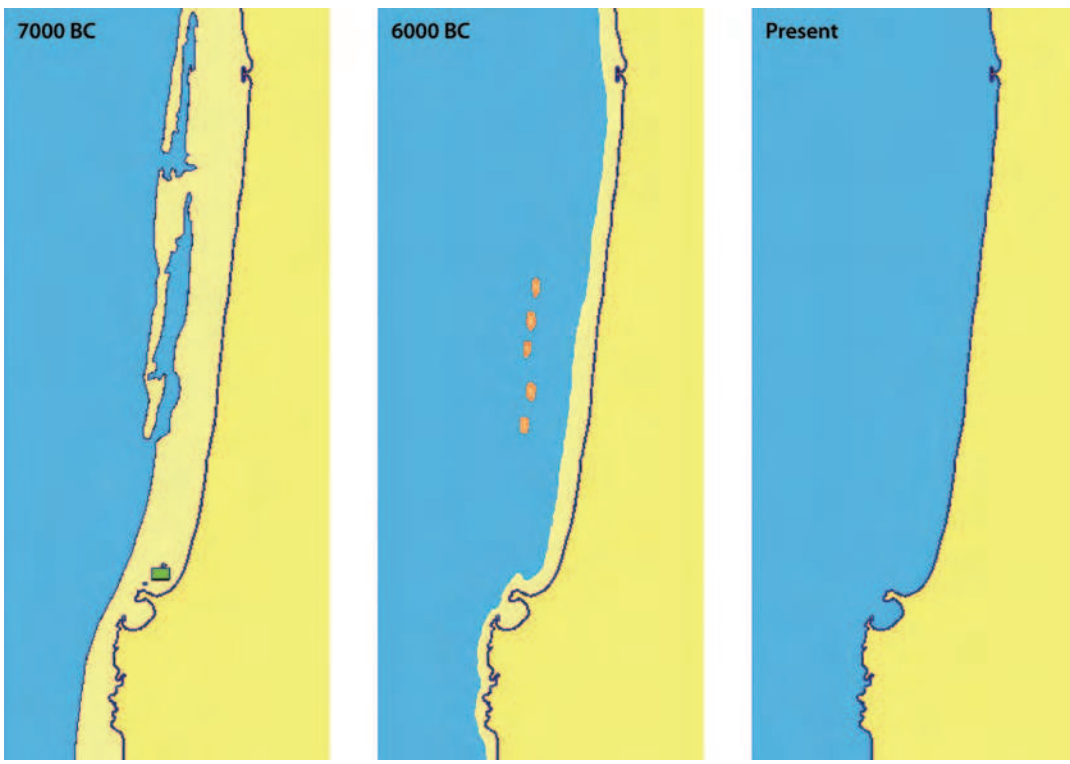

Figure 22.11: Reconstruction of Holocene coastlines on the Carmel coast at c. *7000 cal BC,* c. *6000 cal BC, and the present day*

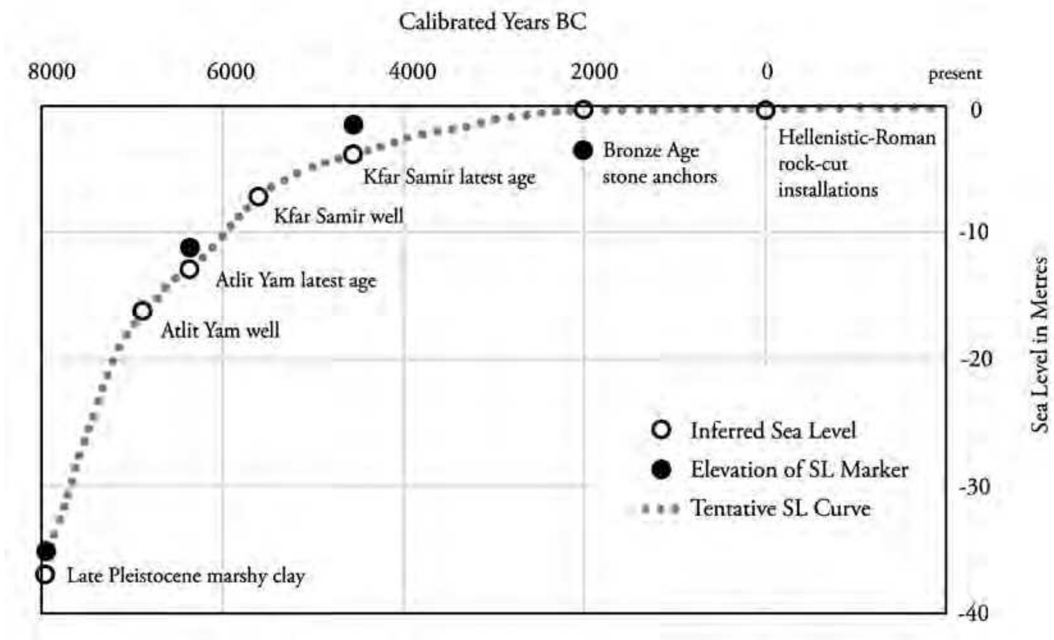

Figure 22.12: Sea-level curve for the Carmel coast based on archaeological evidence

sea level results in a rise in the groundwater table and possible salination of wells. Observations on recent Israeli coastal water wells show that the groundwater table in these is very close to or slightly higher than the present sea level. The natural groundwater table slope in the Israeli coastal plain is in the order of 1:1000 (Kafri and Arad 1978). Thus, the groundwater table for a well that is situated 500 m inland from the shoreline would be 0.5 m above sea level. Studies of ancient wells along Israel's coastal plain showed that the average freshwater depth at the bottom of the wells was about 0.6 m (Nir and Eldar-Nir 1986, 1987, 1988). This column height is dictated by people's ability to dig beneath the water table, and by the fact that it was not necessary to have a deeper water column. An average water column of 0.6 m will generally supply an adequate amount of water.

The Atlit-Yam well bottom is about 15.5 m below modern sea level. This suggests that during the well's initial use, sea level was probably around 16 m (and certainly no more than 15 m) below present sea level (Fig. 22.5). Observations from other submerged wells indicate that during the PN, sea level in the Carmel area was *c.* 10 m lower than today (Galili *et al.* 1988, 2005). Combining these observations with bathymetrical and geological maps of the area makes it possible to present a reconstruction of the sea level and coastal changes along the northern Carmel coast, as shown in Figures 22.11 and 22.12.

It has been suggested that the Atlit-Yam village was destroyed by a catastrophic tsunami event generated by the collapse of a section of Mount Etna (Sicily) into the sea (Pareschi *et al.* 2006, 2007). However, based on current archaeological and geological evidence, it appears that the site was abandoned gradually due to global sea-level rise, rather than as a result of a tsunami (Galili *et al.* 2008).

The emergence of a Mediterranean fishing village

The Levantine and Cilician (southeast Turkish) seashore areas are the closest coastal environments to the inland regions where animals and plants were first domesticated. At the end of the 7th millennium and the beginning of the 6th millennium cal BC farming was practised on the Levantine coast, as evidenced by the material recovered from Atlit-Yam (and possibly also at the sites of Ashkelon Marina (Perrot and Gopher 1996) and Ras Shamra (Van Zeist and Bakker-Heeres 1984). This innovation, the agro-pastoral-marine subsistence system, the so called the Mediterranean fishing village, evolved among indigenous coastal inhabitants, who combined the imported agriculture and animal husbandry with hunting and foraging and intensive marine resource exploitation (Galili *et al.* 2002, 2004). The agro-pastoral components of this subsistence system relied on domesticated cereals and legumes, sheep, goats, and cattle. Subsequently this coastally adapted subsistence system spread westward throughout the Mediterranean basin (Galili *et al.* 2002, 2004).

During the 5th millennium cal BC the extraction of olive oil was added to the economy of the Carmel coast area (Galili *et al.* 1997). The subsistence of the PN settlements was characterized by increased reliance on farming and animal husbandry, reduction of the exploitation of marine resources and hunting, and intensive use of secondary animal products (milk products, wool fibres, etc.). Later still, during the 4th millennium cal BC, other domesticated trees appeared. With the introduction of the domesticated grapevine and the production of wine in the Levant (Zohary and Hopf 2000) alongside the continuation of agro-pastoral food procurement and the exploitation of marine resources, the development of what is today commonly known as 'the Mediterranean diet' was completed around 3000 cal BC.

Early tuberculosis

Bones of a woman buried together with an infant at Atlit-Yam showed pathological deformations suggestive of tuberculosis (Hershkovitz and Galili 1990; Galili *et al*. 2005). Molecular examination of DNA from bones of both individuals yielded positive indications for this disease (Hershkovitz *et al*. 2008; Donoghue *et al*. 2009). It is believed that this is the earliest confirmed report of tuberculosis in humans (Roberts and Buikstra 2003). Previously, the earliest examples were from Predynastic Egypt, 3500–2650 BC (Zink *et al*. 2001), and Italy at the beginning of the 4th millennium cal BC (Formicola *et al.* 1987).

At Atlit-Yam cattle bones dominate the zooarchaeological record indicating their importance as a major dietary component. The absence of detectable *Mycobacterium bovis* (the bacterium that causes tuberculosis in cattle) in the cattle bones is interesting. It could be seen to support the theory for the spread of the disease as a result of a dense human population, rather than as a product of close contact with domestic cattle.

Separating the dead from the living

Salvage excavations and surveys in the submerged PN settlement of Neve-Yam (early to middle 6th millennium cal BC) revealed unique stone-built graves concentrated in a section of the site devoted to burials and related symbolic activities associated with death and mourning. It is significant to note that there were no signs of dwellings in the area of concentrated burials and, similarly, no graves in the dwelling area. The oval graves, oriented east to west, were built with undressed stones and covered by stone slabs. Previously, cist graves have been documented elsewhere in the Levant (cf. Banning 1995). This site is, however, one of the earliest known Neolithic settlements to exhibit a clear division between the living area and the cemetery. Three large concentrations of charred seeds in the cemetery zone suggest ceremonial activities, perhaps representing an early example of a ritual associating the dead with farming activities.

The evolution of extramural burial grounds in the southern Levant is demonstrated in several stages at the submerged PPNC and PN settlements off the Carmel coast. In PPNC Atlit-Yam burials were dispersed all over, but 45 of the 63 burials are concentrated in the site's northwest section (areas K and L). In PN Neve Yam**,** some 1200 years later than Atlit-Yam, burials were definitely concentrated in a separate section of the site devoted to burials and associated activities. During the Chalcolithic period, off-site and well-defined formalized cemeteries containing stone-built graves and ossuaries (made of stone or clay and imitating houses) are common in the southern Levant (Gilead 1988; Gal *et al.* 1995; Levy 1995; Gorzalaczany 2006).

This extramural mode of burial, which emerged, evolved and consolidated during the Neolithic period owing to the sedentary way of life associated with agriculture, has been practised by many human societies until today. It is proposed that the increasing penetration of the subsurface space by soil working and sedentary communities interfered with the dead and was a major factor in the evolution of the separated burial ground, the 'graveyard'. The new institution, 'the separated burial ground', was meant to resolve a three-dimensional territorial conflict between the dead and the living over the use of subsurface space.

Conclusions

Excavations of submerged settlements off the Carmel coast of Israel have demonstrated the development of a society moving toward an

Figure 22.13: Foundations of rectangular dwellings from the PN Neve-Yam site undergoing erosion (Photo: Josef Galili)

agricultural and sedentary lifestyle in the coastal area. Throughout this process, the diet of the inhabitants of the settlements was also dependent on marine resources. It appears that the sites were abandoned gradually as a response to sea-level rise, not as a consequence of dramatic flooding or tsunami. The discoveries at the inundated Atlit-Yam site demonstrate the existence of well-digging technology in this coastal region as early as the beginning of the 7th millennium cal BC, considerably earlier than in other Levantine territories inland. These are some of the many environmental and culture-historic conclusions that can be drawn from the rich *in situ* evidence of settlement, burials, wells, and faunal and floral remains found by archaeologists equipped with standard scuba diving equipment.

Even on the basis of this brief summary of evidence, it should be clear that the submerged Neolithic coastal settlements of the Carmel area hold crucial information for understanding the origins and diffusion of Neolithic lifeways in the Old World. For the future, underwater archaeology is likely to be the main source of new information on Neolithic coastal settlements.

The highest potential for finding submerged Neolithic settlements is in areas where special geological, environmental, and cultural factors have combined. Such sites are located near the coast, where natural factors or human actions cause erosion and exposure of palaeosols (Fig. 22.13). At times, the fringes of such sites can be traced on land. Thus surveys and excavation efforts should be concentrated in areas with these characteristics. An example of such conditions is found at water depths of 1–10 m off the Carmel coast, where the sediment cover is not too thick (enabling exposure) and not too thin (enabling preservation). In the Neve-Yam and Tel Hreiz sites, sections of the submerged settlements were first identified on land (Wreschner 1977a, 1977b, 1983; Ronen and Olami 1978; Olami 1984). However, most of the cultural deposits, structures and artefacts from the submerged prehistoric sites off the Carmel coast were discovered in the course of pre-planned, systematic surveys and excavations, undertaken since 1965 in the most promising areas.

We see no reason why other settlements of comparable age and preservation quality should not exist in shallow waters elsewhere along the Levantine coast. What may be found in deeper parts of the Levantine continental shelf can only be guessed at since these areas have not yet been subject to systematic archaeological surveys and testing.

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References

Alon, D. 1988. The distribution and history of Chalcolithic settlements on the southern coastal plain of Israel. In Urman, D. and Stern, E. (eds) *Man and Environment in Southern Shefela.* Give'atayim, Massada Publishing House: 84–88. [In Hebrew]

Banning, E. B. 1995. Herders or homesteaders? A Neolithic farm in Wadi Ziqlab, Jordan. *Biblical Archaeologist* 58: 2–13.

Bronk Ramsey, C. 2009. Bayesian analysis of radiocarbon dates. *Radiocarbon* 51: 337–360.

Carmi, I. and Segal, D. 1996. Unpublished Report no. 80. Radiocarbon Dating Laboratory ESER Department. Rehovot, Weitzmann Institute of Science.

Donoghue, H. D., Hershkovitz, I., Minnikin, D. E., Besra, G. S., Lee, O. Y. C., Galili, E., Greenblatt, C. L., Lemma, E., Spigelman M. and Kahila Bar-Gal, G. 2009. Biomolecular archaeology of ancient tuberculosis: response to 'Deficiencies and challenges in the study of ancient tuberculosis DNA' by Wilbur *et al.* (2009). *Journal of Archaeological Science* 36: 2792–2804.

Formicola, V., Milanesi, Q. and Scarsini, C. 1987. Evidence of spinal tuberculosis at the beginning of the fourth millennium BC from Arene Candide cave (Liguria, Italy). *American Journal of Physical Anthropology* 72: 1–7.

Gal, Z., Smithline, H. and Shalem, D. 1995. Peqi'in. *Excavations and Surveys in Israel* 16: 22–23.

Galili, E. 2004. *Submerged Settlements of the Ninth to Seventh Millennia BP off the Carmel Coast*. Unpublished PhD thesis, University of Tel Aviv.

Galili, E. and Nir, Y. 1993. The submerged Pre-Pottery Neolithic water well of Atlit-Yam, northern Israel, and its palaeoenvironmental implications. *The Holocene* 3: 265–270.

Galili, E. and Weinstein-Evron, M. 1985. Prehistory and paleoenvironments of submerged sites along the Carmel coast of Israel. *Paléorient* 11(1): 37–52.

Galili, E., Weinstein-Evron, M. and Ronen, A. 1988. Holocene sea-level changes based on submerged archaeological sites off the northern Carmel coast in Israel. *Quaternary Research* 29: 36–42.

Galili, E., Weinstein-Evron, M. and Zohary, D. 1989. Appearance of olives in submerged Neolithic sites along the Carmel coast. *Mitekufat Haeven* 22: 95–97.

Galili, E., Weinstein-Evron, M., Hershkovitz, I., Gopher, A., Kislev, M., Lernau, O., Kolska-Horowitz, L. and Lernau, H. 1993. Atlit-Yam: a prehistoric site on the sea floor off the Israeli coast. *Journal of Field Archaeology* 20: 133–157.

Galili, E., Stanley, D. J., Sharvit, J. and Weinstein-Evron, M. 1997. Evidence for earliest olive-oil production in submerged settlements off the Carmel coast, Israel. *Journal of Archaeological Science* 24: 1141–1150.

Galili, E., Sharvit, J. and Nagar, A. 1998. Nevé-Yam – underwater survey. *Excavations and Surveys in Israel* 18: 35–36.

Galili, E., Rosen, B., Gopher, A. and Horwitz, L. K. 2002. The emergence and dispersion of the Eastern Mediterranean fishing village: evidence from submerged Neolithic settlements off the Carmel coast, Israel. *Journal of Mediterranean Archaeology* 15: 167–198.

Galili, E., Lernau, O. and Zohar, I. 2004. Fishing and marine adaptations at Atlit-Yam, a submerged Neolithic village off the Carmel coast, Israel. *Atiqot* 48: 1–34.

Galili, E., Eshed, V., Gopher, A. and Hershkovitz, I. 2005. Burial practices at the submerged PPNC site of Atlit-Yam, northern Coast of Israel: what do they tell us about the final phase of the Pre-Pottery Neolithic Culture? *Bulletin of the American Schools of Oriental Research* 339: 1–19.

Galili, E., Horwitz, L. K., Hershkovitz, I., Eshed, V., Salamon, A., Zviely, D., Weinstein-Evron, M. and Greenfield, H. 2008. Comment on 'Holocene tsunamis from Mount Etna and the fate of Israeli Neolithic communities' by Maria Teresa Pareschi, Enzo Boschi, and Massimiliano Favalli. *Geophysical Research Letters* 35, L08311, doi:10.1029/2008GL033445.

Garfinkel, Y., Vered, A. and Bar-Yosef, O. 2005. The domestication of water: the Neolithic well at Sha`ar Hagolan, Jordan Valley, Israel. *Antiquity* 80: 686–696.

Gilead, I. 1988. The Chalcolithic period in the Levant. *Journal of World Prehistory* 2: 397–443.

Gorzalaczany, A. 2006. Palmahim. *Hadashot Archeologiyot* 118: 1–4.

Hershkovitz, I. and Galili, E. 1990. 8000 year-old human remains on the sea floor near Atlit, Israel. *Human Evolution* 5: 319–358.

Hershkovitz, I., Donoghue, H., Minnikin, D., Besra, G., Lee, O., Gernaey, A. M., Galili, E., Eshed, V., Greenblatt, C., Lemma, E., Kahila Bar-Gal, G. and Spigelman, M. 2008. Detection and molecular characteristics of 9000-year-old *Mycobacterium tuberculosis* from a Neolithic settlement in the Eastern Mediterranean. *PLoS ONE* 3(10): e3426.

Horwitz, L. K., Galili, E., Sharvit, J. and Lernau, O. 2002. Fauna from five submerged Pottery Neolithic sites off the Carmel coast. *Mitekufat Haeven* 32: 147–174.

Horwitz, L. K., Lernau, O. and Galili, E. 2006. Fauna from the Pottery Neolithic site of Neve-Yam. *Mitekufat Haeven* 36: 139–171.

Kafri, U. and Arad, A. 1978. Paleohydrology and migration of the groundwater divide in regions of tectonic instability in Israel. *Geological Society of America Bulletin* 89: 1723–1732.

Levy, T. E. 1995. Cult, metallurgy, and rank societies – Chalcolithic period (ca 4500–3500 BCE). In Levy, T. E. (ed.) *The Archaeology of Society in the Holy Land*. London, Leicester University Press: 226–244.

Mellaart, J. 1961. Excavations at Hacilar. Fourth preliminary report, 1960. *Anatolian Studies* 11: 39–75.

Nir, Y. and Eldar-Nir, I. 1986. Eustatic sea level changes and their possible influence on the Nile littoral-cell beaches. In Raukas, A. (ed.) *Evolution and Dynamics of Seacoasts in Conditions of Relative Sea Level Oscillation. International Symposium*. Tallinn: 63.

Nir, Y. and Eldar-Nir, I. 1987. Ancient wells and their geoarchaeological significance in detecting tectonics of the Israel Mediterranean coastline region. *Geology* 15: 3–6.

Nir, Y. and Eldar-Nir, I. 1988. Construction techniques and building materials used in ancient water wells along the coastal plain of Israel. In Marinos, P. G. and Koukis, G. C. (eds) *Engineering Geology of Ancient Works, Monuments and Historical Sites.* Rotterdam, Balkema: 1765–1771.

Olami, Y. 1984. *Prehistoric Carmel*. Jerusalem, Israel Exploration Society.

Pareschi, M. T., Boschi, E. and Favalli, M. 2006. Lost tsunami. *Geophysical Research Letters* 33, L22608, doi:10.1029/2006GL027790.

Pareschi, M. T., Boschi, E. and Favalli, M. 2007. Holocene tsunamis from Mount Etna and the fate of Israeli Neolithic communities. *Geophysical. Research. Letters* 34, L16317, doi:10.1029/2007GL030717.

Peltenburg, E., Croft, P., Jackson, A., McCartney, C. and Murray, M. A. 2001. Well-established colonists: Mylouthkia 1 and the Cypro-Pre-Pottery Neolithic B. In Swiny, S. (ed.) *The Earliest Prehistory of Cyprus: From Colonization to Exploitation*. Boston, American Schools of Oriental Research: 61–94.

Perrot, I. and Gopher, A. 1996. A Late Neolithic site near Ashkelon. *Israel Exploration Journal* 46: 145–166.

Reimer, P. J., Baillie, M. G. L., Bard, E., Bayliss, A., Beck, J. W., Blackwell, P. G., Bronk Ramsey, C., Buck, C. E., Burr, G. S., Edwards, R. L., Friedrich, M., Grootes, P. M., Guilderson, T. P., Hajdas, I., Heaton, T. J., Hogg, A. G., Hughen, K. A., Kaiser, K. F., Kromer, B., McCormac, F. G., Manning, S. W., Reimer, R. W., Richards, D. A., Southon, J. R., Talamo, S., Turney, C. S. M., Van der Plicht, J. and Weyhenmeyer, C. E. 2009. IntCal09 and Marine09 radiocarbon age calibration curves, 0–50,000 years cal BP. *Radiocarbon* 51: 1111–1150.

Roberts, C. A. and Buikstra, J. E. 2003. *The Bioarchaeology of Tuberculosis: A Global View on a Reemerging Disease*. Gainesville, University Press of Florida.

Ronen, A. and Olami, Y. 1978. *Atlit Map*. Jerusalem, Archaeological Survey of Israel.

Tsuk, Z. 2000. *Ancient Water Installations in Israel from the Neolithic Period to the End of the Iron Age.* Unpublished PhD thesis, University of Tel Aviv. [In Hebrew]

Van Zeist, W. and Bakker-Heeres, J. A. H. 1984. Archaeobotanical studies in the Levant 2: Neolithic and Halaf levels at Ras Shamra. *Palaeohistoria* 26: 151–170.

Weiner, J. 1998. Drei Brunnenkästen, aber nur zwei Brunnen: eine neue Hypothese zur Baugeschichte des Brunnens von Erlelenz-Kückhoven. In Koschik, H. (ed.) *Brunnen der Jungsteinzeit. Internationales Symposium in Erkelenz 27. bis 29. Oktober 1997*. Köln, Rheinland-Verlag: 95–112.

Wreschner, E. E. 1977a. Neve-Yam, a submerged Late Neolithic settlement near Mount Carmel. *Eretz Israel* 13: 260–271.

Wreschner, E. E. 1977b. Sea level changes and settlement location in the coastal plain of Israel during the Holocene. *Eretz Israel* 13: 277–282.

Wreschner, E. E. 1983. The submerged Neolithic village 'Neve-Yam' on the Israeli Mediterranean coast. In Masters, P. M. and Flemming, N. C. (eds) *Quaternary Coastlines and Marine Archaeology*. London, Academic Press: 325–333.

Zarins, J. 1979. Rajajil – a unique Arabian site from the fourth millennium B.C. *Atlal: Journal of Saudi Arabian Archaeology* 3: 73–77.

Zink, A. R., Haas, C. J., Szeimies, U., Reischl, U. and Nerlich, A. 2001. Molecular analysis of skeletal tuberculosis in an ancient Egyptian population. *Journal of Medical Microbiology* 50: 355–366.

Zohary, D. and Hopf, M. 2000. *Domestication of Plants in the Old World*. 3rd Edition. Oxford, Oxford University Press.