Antiquity 2024 Vol. 98 (398): 343–362
https://doi.org/10.15184/aqy.2024.32

Research Article

Continuity and climate change: the Neolithic coastal settlement of Habonim North, Israel

Roey Nickelsberg[1,*], Thomas E. Levy[2,3,4], Ruth Shahack-Gross[1,2], Anthony Tamberino[3,4], Scott McAvoy[4,5], Gal Bermatov-Paz[1], Nimrod Marom[1,2], Ehud Arkin Shalev[1,2], Ehud Weiss[6], Suembikya Frumin[6] & Assaf Yasur-Landau[1,2,4]

[1] Department of Maritime Civilizations, School of Archaeology and Maritime Cultures, University of Haifa, Israel
[2] The Leon Recanati Institute for Maritime Studies, University of Haifa, Israel
[3] Department of Anthropology, University of California, San Diego, USA
[4] Center for Cyber-Archaeology and Sustainability, Qualcomm Institute, University of California, San Diego, USA
[5] Cultural Heritage Engineering Initiative, University of California, San Diego, USA
[6] Martin (Szusz) Department of Land of Israel Studies and Archaeology, Archaeobotany Laboratory, Bar-Ilan University, Israel
* Author for correspondence ✉ rnickelsberg@gmail.com

Sedentary occupation of the southern Levantine coast spans from the Pre-Pottery Neolithic C to the Early Bronze Age Ib phase (*c.* 7000–3100 BC). Sites dating to the Early Pottery Neolithic (*c.* 6400–5500 BC) are scarce, however, potentially reflecting the effects of the 8.2ka climatic event. Here, the authors present the investigations at the submerged site of Habonim North off the Carmel Coast. Typological and radiocarbon dating indicate an Early Pottery Neolithic occupation and evidence for continuity of subsistence and economic strategies with both earlier and later Neolithic cultures. The results indicate the resilience of coastal communities in the face of significant climatic uncertainty and contribute to understanding human responses to environmental change.

Keywords: Israel, Neolithic, climate change, sea-level rise, subsistence, resilience

Introduction

The centuries leading up to the sixth millennium BC are perceived as a key period of development for Neolithic societies across southern Europe, the Aegean, Anatolia, Syria and Mesopotamia. With the spread of Neolithisation from the Near East through western

Received: 1 March 2022; Revised: 15 March 2023; Accepted: 25 May 2023

Anatolia and into Europe came changes in subsistence practices and foodways, and the expansion of pottery production. At the same time, communities were also coping with environmental and climatic challenges in the wake of the 8.2ka event, which saw increased aridity and climate instability in the northern hemisphere (Biehl & Nieuwenhuyse 2016; Biehl & Rosenstock 2022). Some of these challenges, whether short- or long-term, may have precipitated societal adaptations but it is also possible that many Neolithic groups were sufficiently resilient to cope without significant change (Biehl & Rosenstock 2022: 5–6).

In the southern Levant this period is known as the Early Pottery Neolithic (EPN, 6400/6200–5900/5500 BC; Garfinkel 1993; Banning 1998, 2019: 99–100; Twiss 2007: 24–25; Bar & Rosenberg 2011: 32; Goring-Morris & Belfer-Cohen 2020: tab. 1). The relatively limited available radiocarbon database frames two EPN archaeological cultures in the southern Levant—the Yarmukian culture (6300–5800 cal BC) and the Lodian/Jericho IX culture (5900/5800–5600/5500 cal BC) associated with the EPN—followed by the Late Pottery Neolithic (LPN) Wadi Rabah culture (5600/5500–4800 cal BC; Gopher & Barkai 2012: 1533–35). The Neolithic coastal settlements of the southern Levant are characterised by sedentary villages, the earliest being the Pre-Pottery Neolithic C (PPNC; 7000–6400 cal BC) submerged village at Atlit-Yam (Galili *et al.* 1993, 2019: 52) and the contemporaneous coastal site at Ashkelon (Perrot & Gopher 1996; Garfinkel & Dag 2008). Later, a fully developed Mediterranean subsistence economy thrived during the LPN coastal Wadi Rabah culture (e.g. Neve Yam and Kfar Samir; Galili *et al.* 2019: 54). There is, however, a noticeable temporal gap in coastal settlements during the EPN. The best-known Yarmukian sites of EPN date (Sha'ar Hagolan, Jericho and Munḥata) are both located inland (Stekelis 1950; Garfinkel 1993; Banning 2019) and there are only two known coastal EPN sites in Israel—Neve David (Shochat *et al.* 2019) and Habashan Street (Kaplan 1972). A third potential example, from which a wooden basket provides a radiocarbon date of the end of the eighth millennium BP, is the submerged site of Kfar Samir North (Galili *et al.* 2017: fig. 7.2: 5, tab. 7.1). None of these EPN sites presents clear evidence of architecture; instead, all are characterised by pits containing typical EPN ceramic and flint assemblages. These finds are better attributed to ephemeral occupations, especially when compared to assemblages from the larger inland sites of Sha'ar Hagolan or Jericho (Kenyon & Holland 1982; Garfinkel 1993: 117). Presently, Yarmukian finds are known only from Byblos on the Lebanon coast (Dunand 1973; Badreshany 2016: 15).

This fragmented evidence of human coastal occupation in the EPN of the southern Levant coincides with the 8.2ka event and its aftermath, characterised by rapid cooling and arid conditions effectively causing drought in much of the eastern Mediterranean (Bar-Matthews *et al.* 1999: 91; Migowski *et al.* 2006: 425). Through the Holocene, such rapid climate events may have been responsible for shifts in settlement patterns, and even for societal collapse, especially for early farming communities such as the EPN, which relied on precipitation and stable temperatures for agricultural success (Weninger *et al.* 2006; Flohr *et al.* 2016; Matero *et al.* 2017; Rollefson 2020). While the 8.2ka event may have had an adverse effect on some Neolithic communities (e.g. at Çatalhöyük), others may have been less affected (Weninger *et al.* 2006; Flohr *et al.* 2016; Matero *et al.* 2017). The limited number of archaeological sites identified on the coastal plain of the southern Levant indicates that this area may have suffered the effects of climatic instability, though the nature of the impact is

debated (Migowski *et al.* 2006; Maher *et al.* 2011; Flohr *et al.* 2016: fig. 3b; Shochat *et al.* 2019; Rollefson 2020). Here, we present the results of the first excavation at the submerged EPN settlement of Habonim North (Figure 1), shedding new light on the supposed EPN coastal habitation hiatus and offering insights into the social resilience of coastal communities around the 8.2ka climatic event.

Underwater excavation areas and methods

The site of Habonim North is located off the Carmel Coast of Israel, approximately 200m south of Tel Nami, at a depth of 2.5–3.0m below present sea level, between the current coastline and a submerged aeolianite (*kurkar*) ridge (Figure 1). It was first identified (between 2015 and 2017) by Ehud Galili (*pers. comm.*) and rediscovered in 2018 during an underwater archaeological survey (Arkin Shalev *et al.* 2022). Underwater excavations have been conducted jointly by the University of California, San Diego, and the University of Haifa in two main areas: A and B (Figure 1). In total, five 1 × 1m squares and two installations (constructed features within the site) were excavated: two squares in an open space in area A; three squares on either side of two stone walls (W001 and W002; Figure 2); and two round installations (L013 and L015; Figure 2) in area B. The sediments in both areas are rich in anthropogenic remains, including pottery, lithics, bone and botanical assemblages, which provide information about the extent of the site and the intensity of its occupation. Investigations have employed a combination of methods including a water-pump-activated dredge system to remove sand and the manual collection of larger artefacts (Galili *et al.* 1993: 134–35). Stratigraphic excavation, finds collection and documentation (i.e. registration, drawing, photography and 3D modelling) follow terrestrial methods, employing a 0.5 × 0.5m grid and the excavation of 50mm-deep spits (Bar-Yosef & Mazar 1982). All excavated sediments were systematically wet sieved through 2mm, 1mm and 0.5mm geological mesh sieves to recover smaller finds.

Results

Architecture

Excavation has identified three main strata: Stratum I, the most recent, is an approximately 0.5m-thick sand deposit that accumulated over the abandoned site. The underlying Stratum II is represented by contemporaneous architectural features in area B: adjoining walls W001 and W002, the latter delimiting a cobblestone layer into which two stone installations were set. The sediments excavated adjacent to W001 and W002 abutted them and were thus likely the living surfaces associated with these walls. Excavation did not continue below the walls' foundations. The earliest phase, Stratum III, is represented by archaeological sediments excavated within the stone installations, but below the foundation level of their lining stones; these deposits therefore pre-date the installations and possibly the walls as well.

Architectural remains consist of two curvilinear walls on a north-west/south-east axis and two round stone installations. W001, an approximately 8m-long feature, is built of a single row of boulders, standing upright on their narrow edges, ranging from 0.3 × 0.2 × 0.1m to 0.4 × 0.3 × 0.15m (length × width × height; Figure 3a). On either side of the wall are smaller

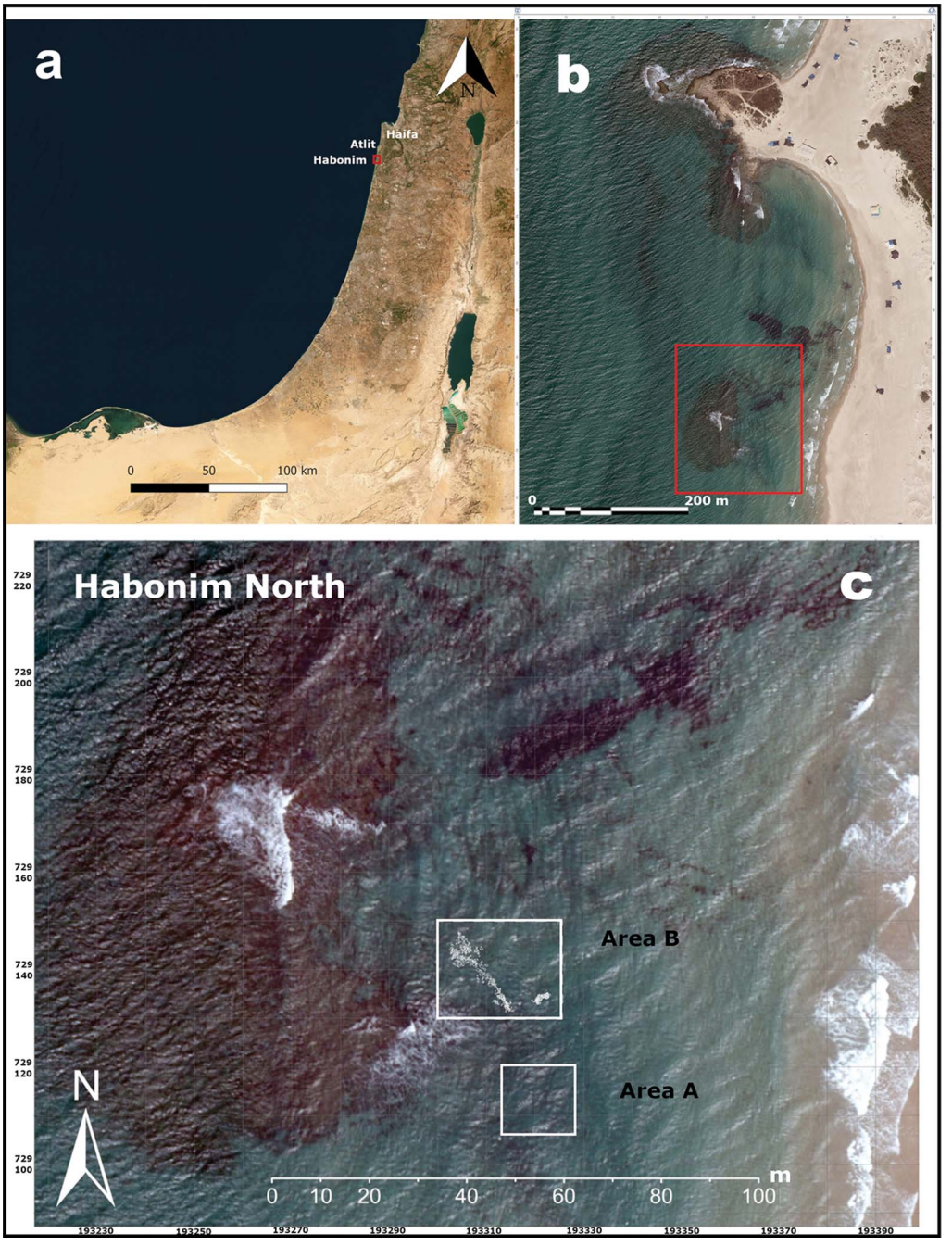

Figure 1. a & b) the submerged Neolithic site of Habonim North, located approximately 100m west of the current shoreline off the Carmel Coast, Israel; c) excavation areas A and B (maps created with Esri and MAPI libraries; figure by authors).

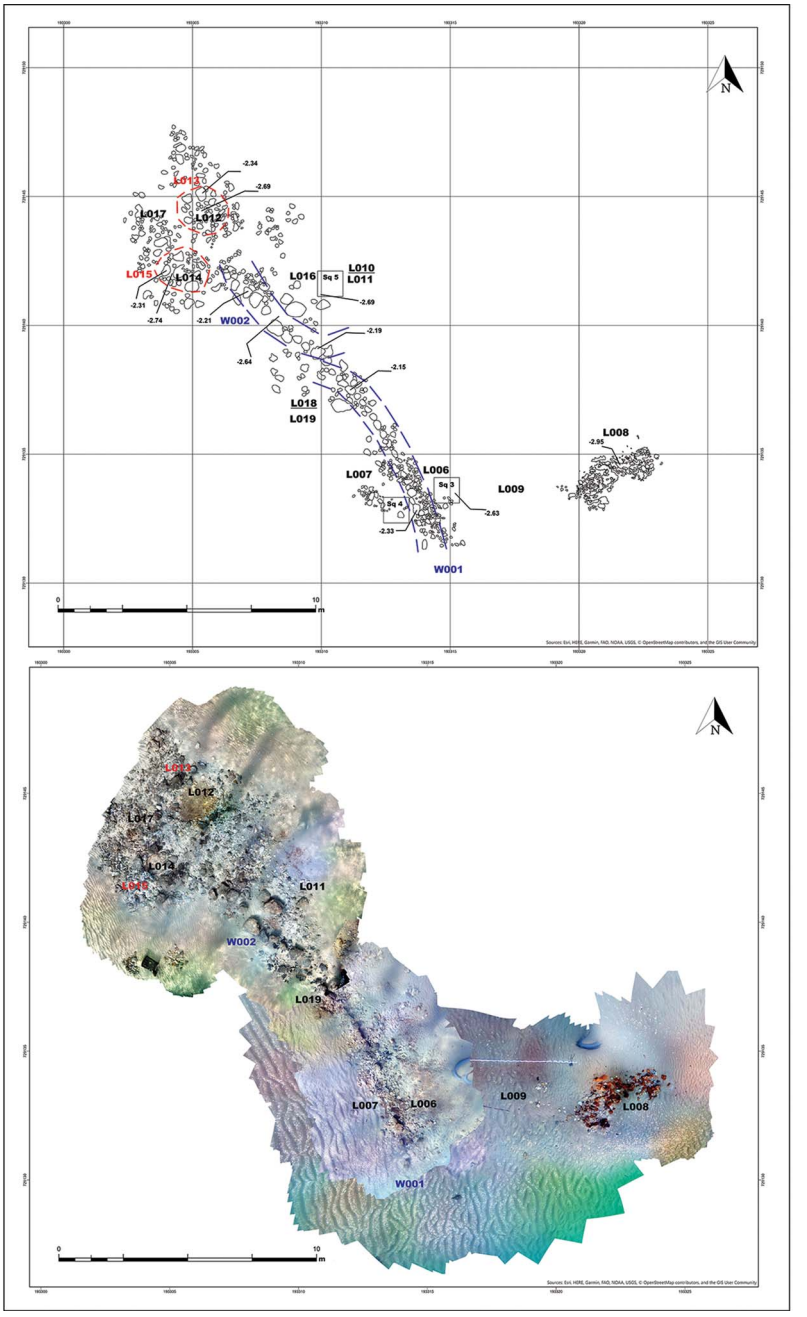

Figure 2. Top half) plan of structures in area B; lower half) orthophoto of excavated contexts in area B (figure by authors).

stones (cobbles) that may have been part of a supporting system. Based on the curvature of the wall, the area to its west is interpreted as the interior of an enclosed structural space, which was excavated as locus (L) 007 (as a 1 × 1m square next to the southern section of the wall) and

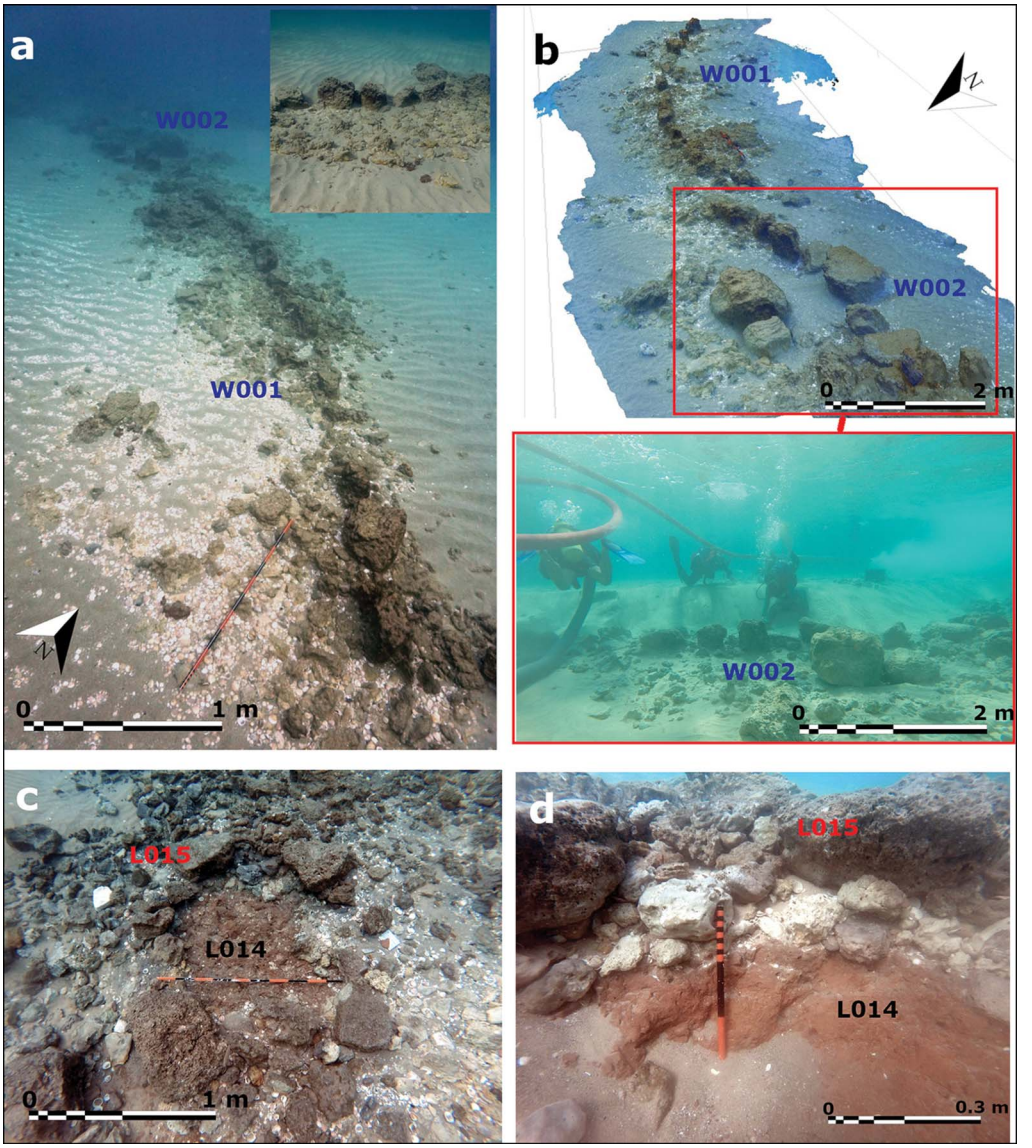

Figure 3. Architectural features identified during excavation: a) wall 001; b) wall 002; c) one of two round-stone installations (L105); d) section of L105 demonstrating shallow nature of features and sediment below them (photographs and figure by authors).

L019 (next to the northern part of the wall, yielding a collection of finds). The area immediately to the east of the wall is interpreted as a space outside the structure and was investigated with another 1 × 1m square (L006). Slightly farther to the east, another finds assemblage was recovered from a habitation surface (L009) representing the same context as L006. Wall 002 abuts W001 on its north-western edge. It too extends from north-west to south-east but curves in the opposite direction to W001, enclosing a space to its east. W002 is

approximately 5m long and constructed of boulders that are larger than those composing W001, ranging in size from 0.5 × 0.3 × 0.2m to 0.6 × 0.4 × 0.3m (Figure 3b). All but one boulder stand upright, encircling a single large boulder to the east of the wall. A 1 × 1m square was excavated in this space (L011).

North-west of W002 is a layer of cobblestones. Such layers have been identified at other Yarmukian sites (e.g. in rooms K and G of Building I at Sha'ar Hagolan; Garfinkel *et al.* 2012: fig. 5), at earlier PPNB sites and in later periods (Roskin *et al.* 2022: 221). This layer includes two round stone-built installations (L013 and L015), both constructed of a single course of stones (0.3 × 0.4 × 0.15m) arranged in a 1.5m-diameter circle (Figure 3c & d). These features may be the remains of pit linings. The 11 sediments excavated from within both structures yielded a variety of finds, including lithics, pottery and charred botanical remains (mainly seeds). The sediment excavated below L015 also contained lithics and charred remains, attesting to an earlier habitation phase at the site.

Ceramic finds

The excavated squares yielded a rather uniform EPN pottery assemblage (n = 32), of value for relative dating. Distinctive EPN characteristics include light-coloured ware with coarse temper, the knob handle from a storage jar (Figure 4, no. 5) and the painted rim of a hole-mouth jar (Figure 4, no. 3). Such vessel types have been recovered from Yarmukian and Jericho IX sites, including Naḥal Zehora II (Strata IV–III), Munḥata (Layer 2b), Ard el-Samra (Area C, Layer 3; Area F, Layer 2) and Neve David (Levels 3–1) (Garfinkel 1993: 118–20; Getzov *et al.* 2009: fig. 29; Gopher & Barkai 2012: 89, 361–62; Shochat *et al.* 2019: fig. 18). Another characteristic EPN attribute of some of the Habonim assemblage is painted decoration, including red-slipped or red-painted bands, common on Jericho IX wares from Neve David and Mishmar Ha'emeq (Figure 5; Barzilai & Getzov 2011: 18; Shochat *et al.* 2019: 171–73); the nearby site of Neve David has yielded decorated sherds almost identical to those from Habonim North (Shochat *et al.* 2019: fig. 18.6–8). Additionally, one sherd (Figure 5, no. 11) bears an incised decoration very similar to the herringbone decoration—a Yarmukian feature, with only a few cases in Jericho IX contexts—which has been identified at Neve David, Mishmar Ha'emeq, Naḥal Zehora and Sha'ar Hagolan (Garfinkel 1993: fig. 4; Barzilai & Getzov 2011: fig. 5.1; Gopher & Baraki 2012: fig. 10.2.24; Shochat *et al.* 2019: fig. 18.5).

Botanical finds

An initial analysis of approximately 300 well-preserved plant remains from seven loci allows species-level identification of most of the material. The assemblage comprises two crop plants, emmer wheat (*Triticum dicoccum*) and lentil (*Lens culinaris*?), plus two obligatory weeds, darnel (*Lolium temulentum*) and brittle-spiked canary grass (*Phalaris paradoxa*), and five wild plants (*Cephalaria joppensis*, *Chenopodium album*, *Lolium rigidum*, *Malva parviflora*, *Scorpiurus* sp.; see online supplementary material (OSM) Table S1). Wheat, lentil and their accompanying weeds would have grown in cultivated fields on fertile and moist soils. The other wild plants include ruderal species and herbaceous and nutrient-rich plants

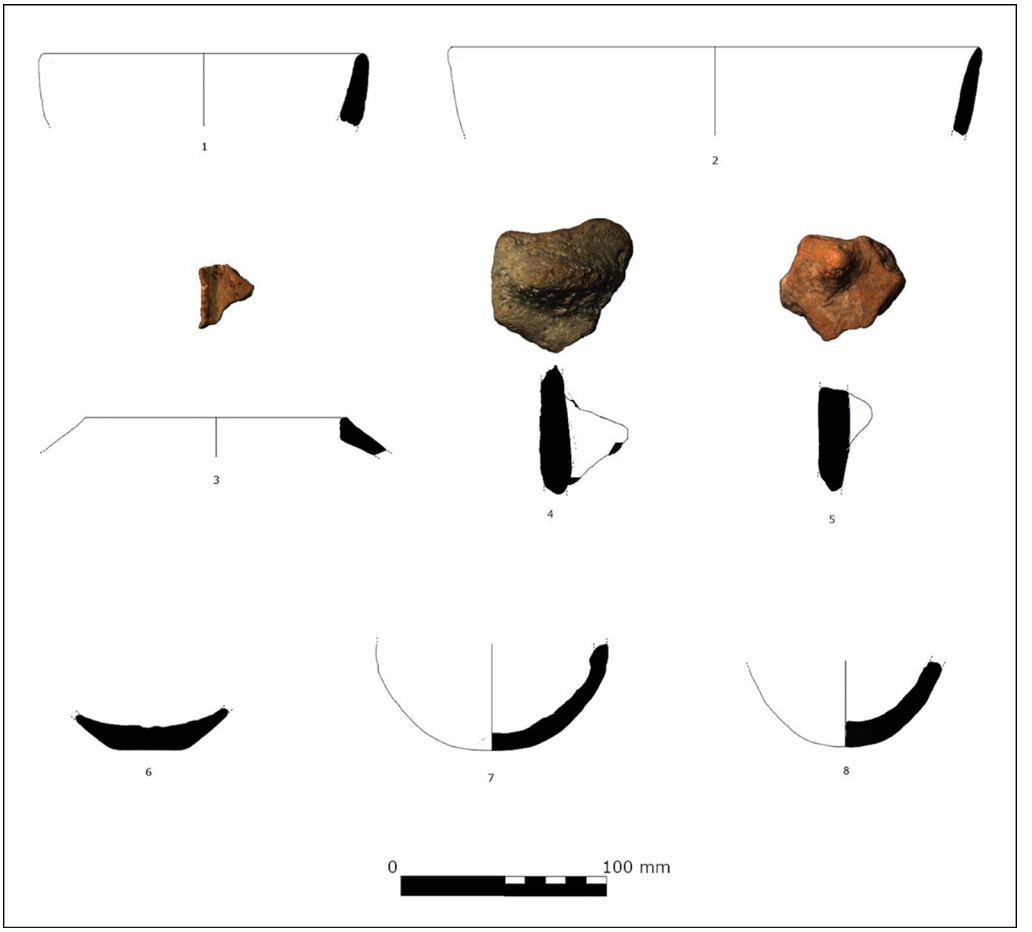

Figure 4. Pottery recovered from area B: (1–3) bowl and holemouth jar rims; (4–5) knob and ledge handles; (6–8) bowl and jug bases (figure by authors).

that grow in various habitats and can be found currently along the Carmel Coast and in neighbouring regions (Danin 2004).

Samples of three charred botanical remains were radiocarbon dated (at Beta Analytic Radiocarbon Laboratory, see OSM Table S2). A wood charcoal sample from burnt sediment in area B associated with the northern face of W002 (Figure 6) yielded a radiocarbon age of 6070–5990 cal BC; two seeds from area A (open space) are dated to 6022–5902 cal BC and 5482–5339 cal BC. The earliest of the two dates from area A and the date of the sample from area B fall within the range of the Jericho IX culture. These dates link the site to the timespan between the Yarmukian and Jericho IX phases (Gopher & Barkai 2012: 1534–35), in agreement with the presence of pottery with characteristics of both cultures at Habonim North. The third radiocarbon date (one of the two from area A) corresponds with the Wadi Rabah phase and may indicate continuous occupation of the site through the LPN.

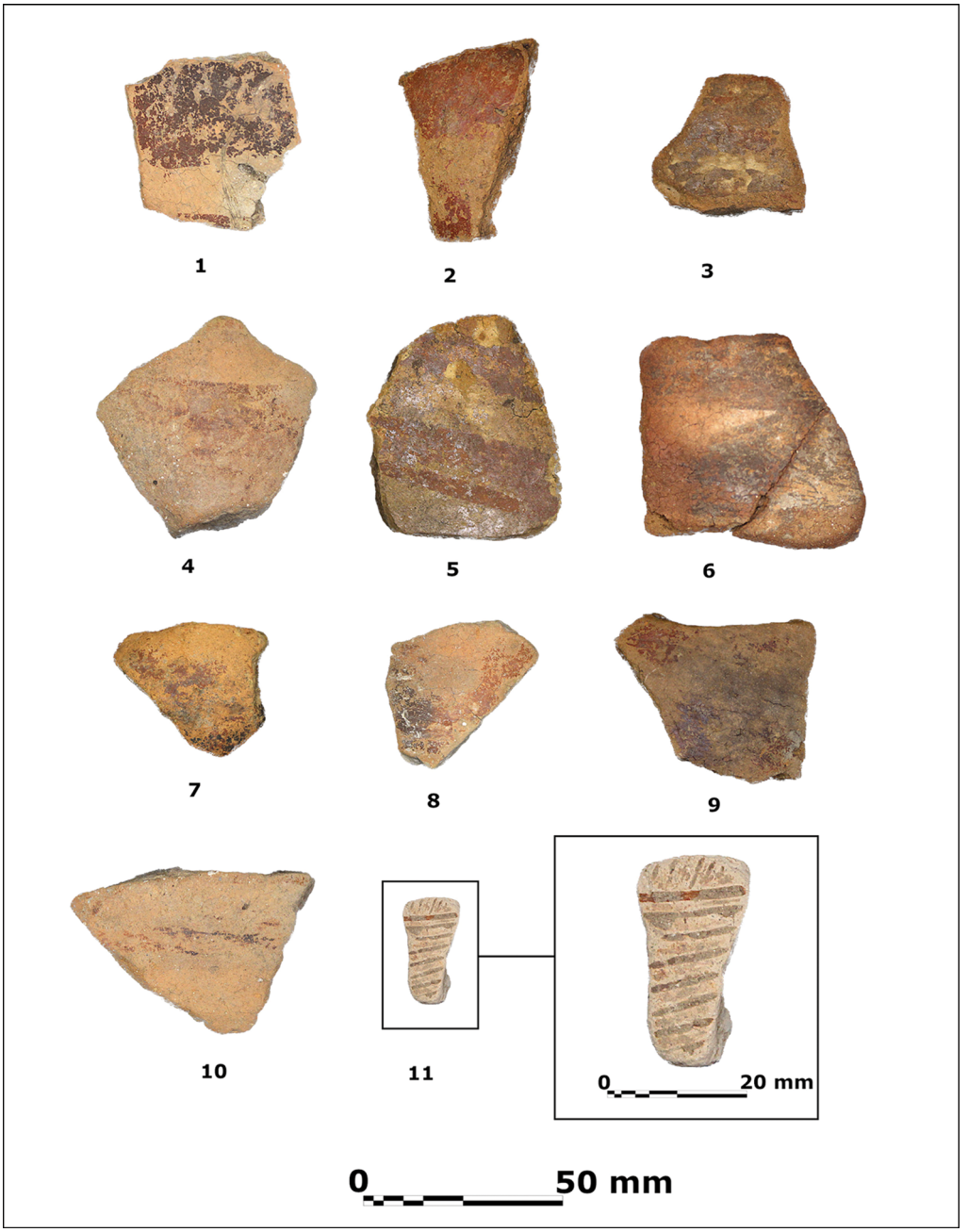

Figure 5. Pottery: sherds with red-painted decorations of the Jericho IX tradition; detail of sherd with red paint and incisions (11), common in Yarmukian/Jericho IX assemblages (figure by authors).

Lithic assemblages

The flint assemblage from Habonim North comprises 187 items, mostly reflecting an ad hoc industry dominated by flake production (n = 65, 34.4%; see Table S3). Cores with two

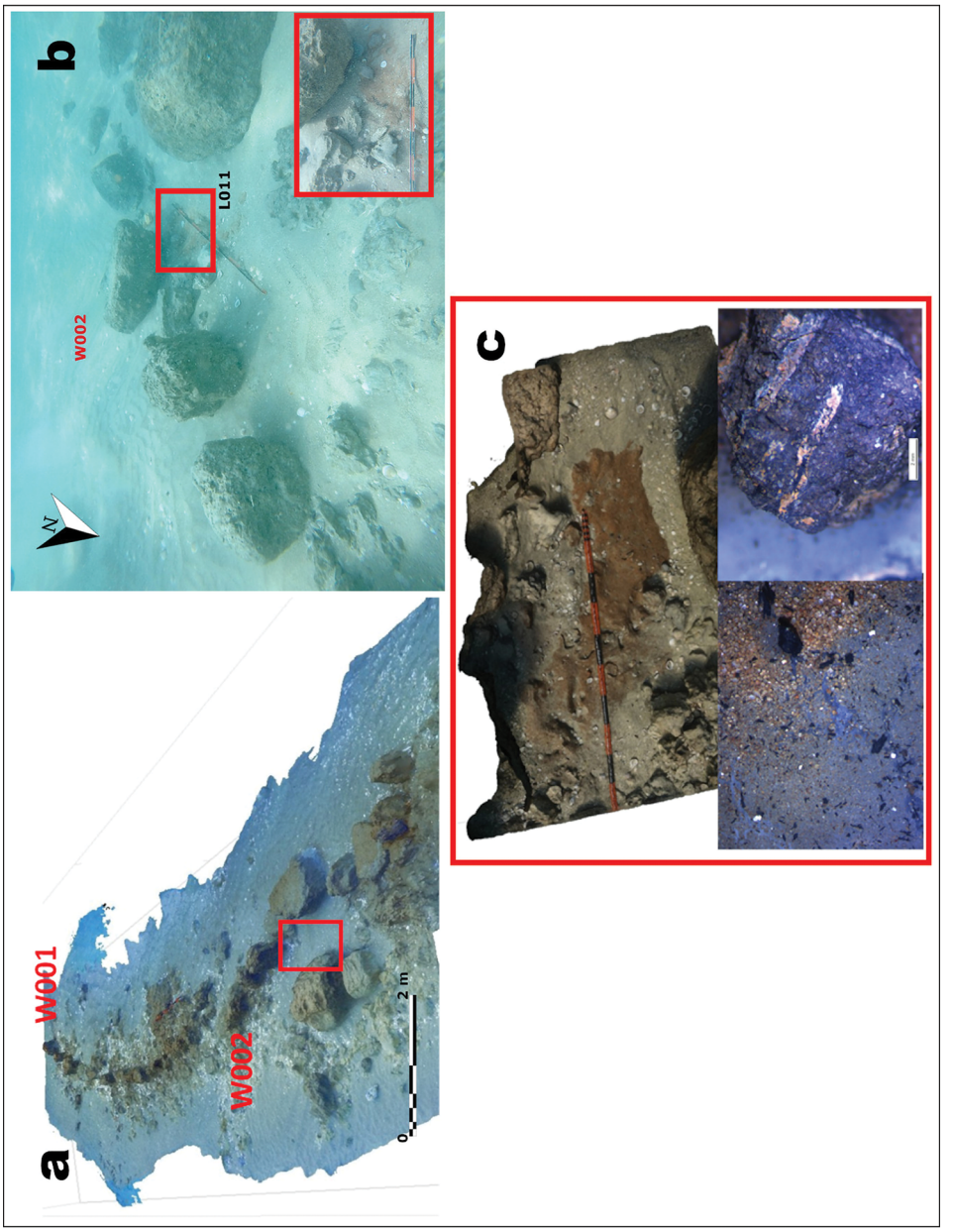

Figure 6. a & b) location of sampled burnt patch near W002; c) sample containing wood charcoal and a mud-brick fragment (see Table S2 for 14C date) (figure by authors).

striking platforms are the most common (n = 17, 47.2%). In four examples the striking platforms are opposed, reflecting bidirectional reduction technology. There are 46 tools from several typological groups (see Table S4), among them bifacial tools (n = 5, 10.9%) including an adze (Figure 7, no. 1) and a broken bifacial tool (Figure 7, no. 2) but no sickle blades or arrowheads. In the Levant, bifacial tools used for woodworking first appear in the Late Epipalaeolithic period and become an important component in Neolithic and Chalcolithic flint assemblages (Barkai & Yerkes 2008; Barkai 2011; Shea 2013). They have been found in submerged PPNC contexts at Atlit-Yam and LPN contexts at Kfar Galim (Galili & Weinstein-Evron 1985: fig. 8; Galili *et al.* 1993: fig. 12). The overall characteristics of the small assemblage from Habonim North place it in the continuum between the PPNC and the LPN, presenting evidence for *in situ* knapping and daily activities (Table S3).

The ground-stone assemblage includes four basalt tools from area B: two mortar fragments (Figure 8a, nos. 1–2), a flat disc-shaped grinding stone (Figure 8a, no. 3) and a fragment of a worked grinding stone with a smoothed/polished surface (Figure 8a, no. 4). Basalt does not occur naturally on the Carmel Coast, and its presence in the assemblage thus

Figure 7. Flint bifacial tools: 1) adze; 2) broken bifacial tool (figure by authors).

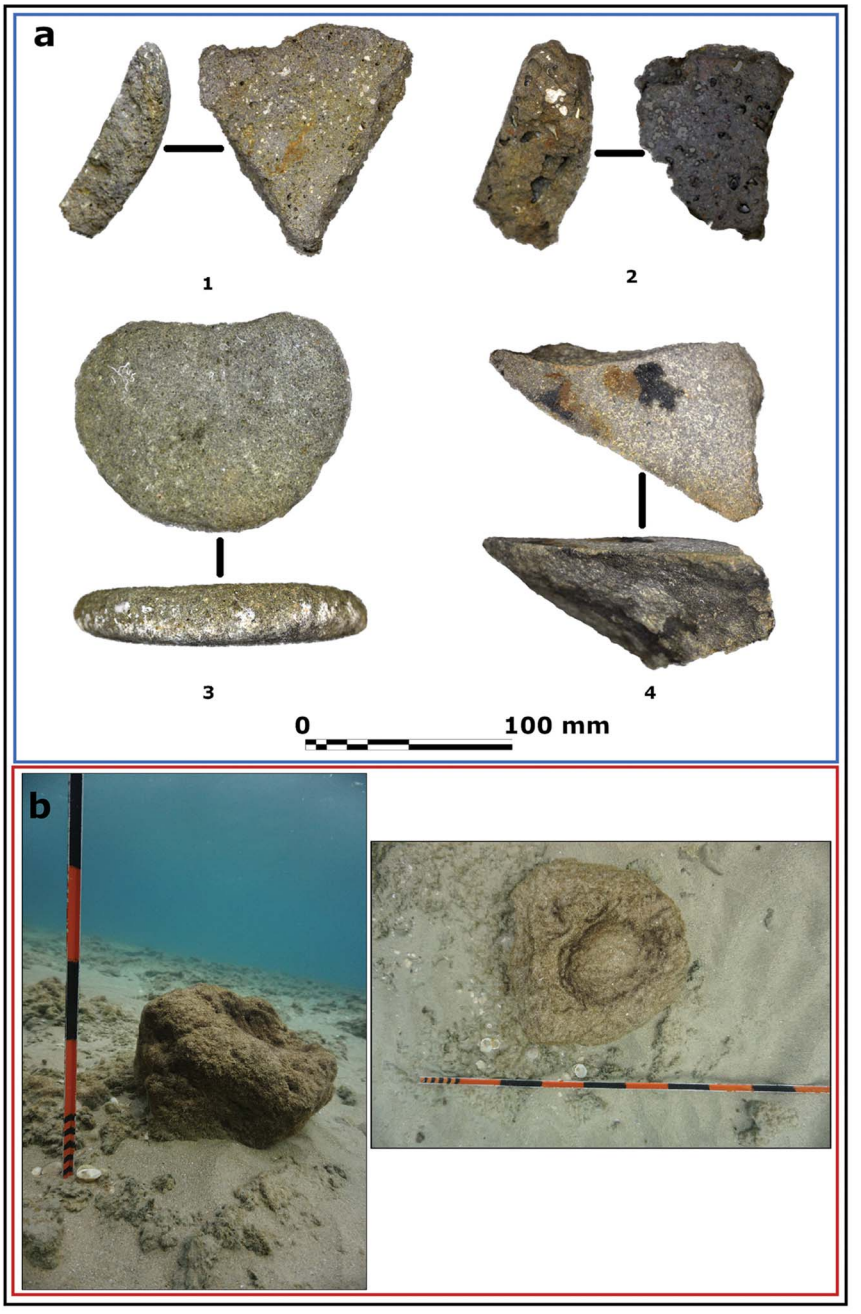

Figure 8. a) basalt ground-stone tools; b) in situ kurkar *bowl (figure by authors).*

indicates the existence of trade networks (see Rosenberg & Garfinkel 2014: 276–77). In addition, a *kurkar* (a local term for coastal aeolian sandstone) feature roughly 0.3 × 0.2m with a circular depression (0.1m diameter) identified as either a stone bowl or a stone with a cup

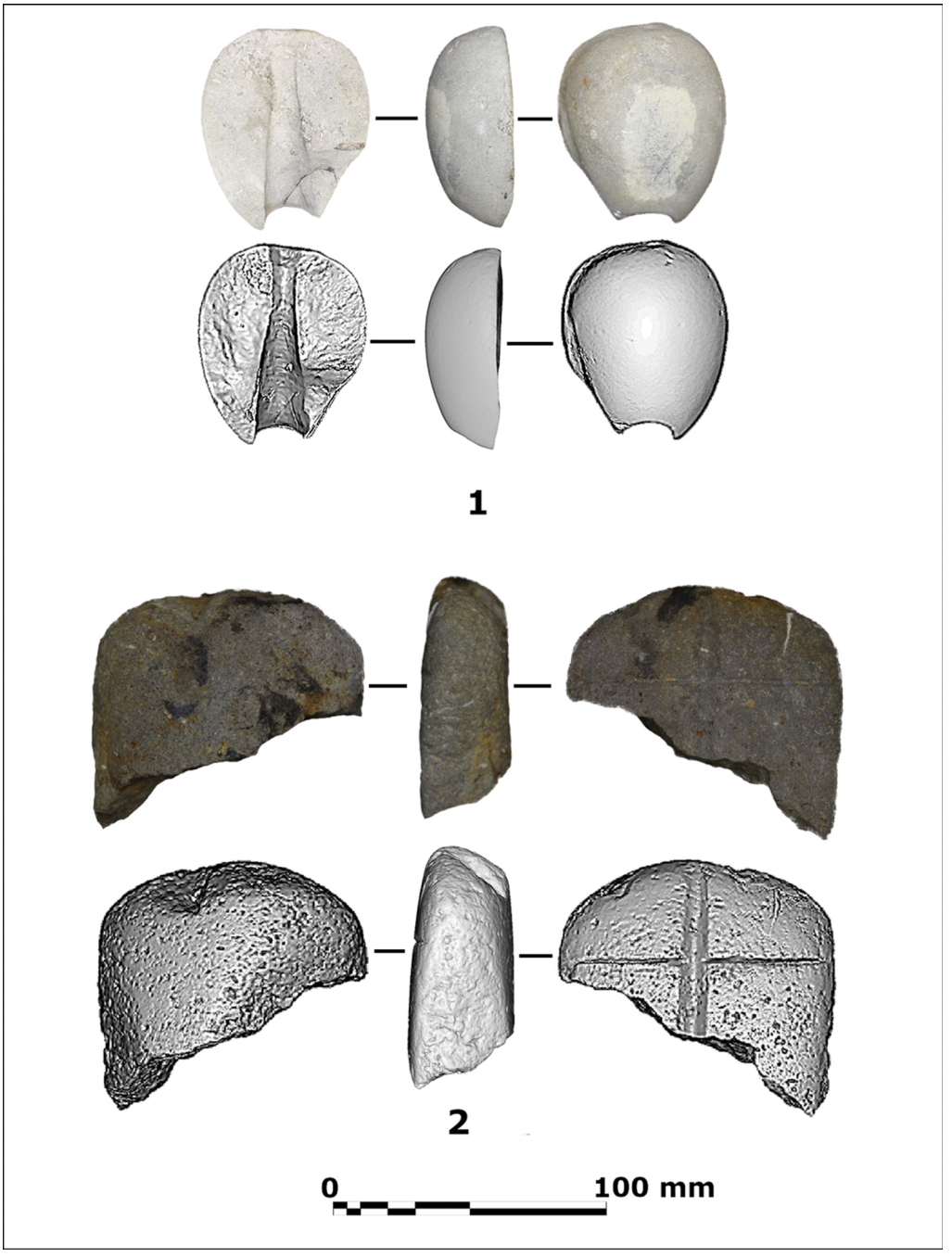

Figure 9. Stone objects: 1) half of a mace-head; 2) basalt pebble with cross incision and possible percussion mark (figure by authors).

Figure 10. Stone objects from area B with connection to marine activities, probably fishing-net sinkers (figure by authors).

mark was found west of W001 and left on site (Figure 8b). Similar items have been recovered at the later LPN site of Kfar Galim (Galili & Weinstein-Evron 1985: fig. 11).

Half of a piriform limestone mace-head was recovered 5m east of W001 (L008). The object is 60mm long and 50mm wide, pierced by a drilled hole and has a smoothed exterior (Figure 9, no. 1). Stone mace-heads are known as early as the PPNB and continue into the Chalcolithic period in the Levant (Rosenberg 2010) and Early Bronze Age (Rosenberg & Golani 2012). In EPN contexts they appear at sites such as Ḥamadiya, ʻAin Ghazal, Naḥal Zehora II and Shaʻar Hagolan, from which 13 were recovered from Sha'ar Hagolan alone (Rosenberg 2010). Along the Israeli Coastal Plain mace-heads have been recovered from LPN sites such as Neve Yam and Tel Kabri (Rosenberg 2010).

Another notable find is an incised oval basalt pebble. The rounded upper part is marked with two perpendicular grooves forming a cross (Figure 9, no. 2). Incised pebbles are commonly recovered from Yarmukian sites in Israel and as far north as Byblos (Dunand 1973) and are common also in seventh-millennium BC Cypriot contexts (Simmons 1994; Clarke 2010). Currently, the largest assemblages of incised pebbles found in Israel come from Shaʻar Hagolan and Munḥata, featuring a variety of incised patterns (Perrot 1964: 328; Gopher & Orrelle 1996; Garfinkel 2014). Some scholars suggest a symbolic meaning for these items, possibly as identity markers, based on their findspots within houses at Shaʻar Hagolan (cf. Garfinkel 2014). One of the pebbles found at Shaʻar Hagolan is a close parallel to the one found at Habonim North, in terms of both material and incised pattern (Garfinkel 2014: fig. 13.20).

Some of the artefacts are related to maritime activities. Several stone fishing net-sinkers were recovered from the site, including the putative internal space of W001 (L007; Figure 10). Fishing net-sinkers are common at coastal sites such as Atlit-Yam and at later LPN sites such as Neve Yam as early as the PPNB and PPNC (Galili *et al.* 1993: fig. 15; 2017: 119). These indicate the continuity of maritime activities from the PPNC to the EPN and later.

Zooarchaeology

A first study of faunal remains from Habonim North has identified the taxa of 10 bones from area B. These are five caprine (sheep or goat) tooth and limb bone fragments, two equine cheek teeth, and a single bone each from Persian fallow deer (*Dama dama mesopotamica*), gazelle (*Gazella gazella*) and wild pig/boar (*Sus scrofa*). This list indicates utilisation of both wild and domestic resources.

Discussion

The data presented above potentially shift understanding of settlement continuity and the effect of the 8.2ka climatic event on coastal communities in the southern Levant.

Evidence of an EPN village at Habonim North

The archaeological finds from the submerged site of Habonim North indicate that it was a settlement dating to the EPN—a phase that has, until now, been almost entirely missing from the archaeological record of the southern Levantine coast. The pottery assemblage at Habonim North is dominated by red-painted sherds and incised decoration that are typical of the Yarmukian and Jericho IX cultures. An incised basalt pebble, common in Yarmukian assemblages (Gopher & Orrelle 1996; Garfinkel 2014), also supports an EPN date for the site. Similar incised basalt pebbles were discovered in Shaʿar Hagolan and Byblos (Dunand 1973; Garfinkel 2014; Badreshany 2016).

Other lithic finds point to the Pottery Neolithic more generally. Two of the three radiocarbon dates presented here place the site at the end of the sixth millennium BC—corresponding either with the late Yarmukian or the start of the Jericho IX culture—while a third radiocarbon date hints at the possibility of continuing occupation through the subsequent Wadi Rabah phase (Gopher & Barkai 2012: 1534–35; Banning 2019). This correlation between typological and absolute dating presents the first indication of an EPN settlement on the Carmel Coast. At Neve David, EPN occupation was deduced strictly from the pottery assemblage, which is similar to that found at Habonim North; while at Kfar Samir, the recovery of a basket provided a radiocarbon date from this period in the absence of any clear archaeological context (Shochat *et al.* 2019).

The new radiocarbon dates from Habonim North coincide with the latest dates from PPNC Atlit-Yam (Galili *et al.* 1993) and the earliest LPN Wadi Rabah sites along the Carmel Coast (Galili *et al.* 2019: 52), thus bridging this chronological gap. As a result, the site of Habonim North fills the last supposed gap in the coastal habitation record, which is believed to have lasted until the Early Bronze Age phase Ib (Yasur-Landau 2019; Nickelsberg *et al.* in press).

First signs of EPN architecture on the coast

EPN structures on the eastern Mediterranean coast are rare, previously encountered only at Byblos. Furthermore, only a few inland EPN sites have yielded architectural remains, including Shaʿar Hagolan, Munḥata, Hagoshrim, Jericho and ʿAin Ghazal—the latter displaying reused PPNB structures (Perrot 1964: 325–26; Garfinkel 1993: 127–28; 2006: 104–5; Getzov 1999; Kafafi 2006). At Mishmar Haʿemeq, Ard el-Samra and Neve David only pit dwellings were identified (Getzov *et al.* 2009; Barzilai & Getzov 2011; Shochat *et al.* 2019).

The features W001 and W002 at Habonim North may represent two types of structure. The first, with a row of stones placed on their narrow edge, is similar to partition walls identified between household units at ʿAin Ghazal (Kafafi 2006: 83–84). The second is probably the outer lining of a thicker wall, such as that of Complex II at Shaʿar Hagolan or walls identified at Munḥata (Perrot 1964: 325–27; Garfinkel *et al.* 2012: figs. 4 & 9).

The effect of the 8.2ka climatic event on coastal communities

The evidence from Habonim North is incompatible with the collapse of coastal settlements in the wake of the 8.2ka event. Instead, it presents a resilient, sedentary site with a complex and diverse economic system that included local production as well as long-distance exchange postdating the 8.2ka climatic event.

The roots of this resilience probably lie in a combination of the already robust subsistence economy of the PPNC and additional diversification efforts made to buffer climatic uncertainty (e.g. Ryan & Rosen 2016). The domesticated plant remains from Habonim North show a continuity of the Mediterranean subsistence economy with similarities to the botanical assemblages from PPNC Atlit-Yam—that is, the presence of wheat and lentils (Kislev *et al.* 2004; Hartmann-Shenkman *et al.* 2015)—and the LPN site of Naḥal Zehora II (Kislev & Hartmann 2012). Wheat was the main food crop during the PPNC and continued its role in EPN Habonim North and LPN Naḥal Zehora. Likewise, lentils continued to accompany wheat throughout these periods. The two *Lolium* species are also represented at all three sites. At the same time, *Malva parviflora* and *Phalaris paradoxa* are present only at the two early sites, Atlit-Yam and Habonim North. Similarities in the main crops, their weeds and the wild plants indicate the continuity of agricultural practices in the Carmel Coast area from the PPNC to the Pottery Neolithic. The zooarchaeological assemblage also indicates the utilisation of domestic and wild animals, while fishing appears to have supplemented the diet of the local community, resembling the economic system at PPNC Atlit-Yam.

Diversification is evident in the addition of non-local raw materials and goods, which likely arrived through exchange. This is seen in the basalt finds, made of a material that is not found along the Carmel Coast, which have typological parallels from inland sites. Unexpected evidence of diversification is seen in the heterogeneous provenance (i.e. at last two sources, a local coastal and imported coastal) of pottery (see OSM: Ceramic petrography), a technological innovation and new addition to the EPN material repertoire. These results suggest that the village communities established during the PPNC represent the foundations of a resilient society capable of withstanding environmental changes that would have disrupted or displaced earlier societies.

Conclusion

The site of Habonim North offers new evidence showing how coastal EPN societies in the southern Levant successfully navigated the climatic uncertainty associated with the 8.2ka event. While a break in the settlement record at this time was hypothesised to suggest that this event may have precipitated the abandonment of coastal settlements, the data provided here show that the social and economic systems that were established during the PPNC continued into the EPN and contributed to the ability of communities to withstand the stress of environmental and climate change. Control and management of local resources even enabled the introduction of new types of material culture during this period of uncertainty. These results indicate that early Neolithic societies were resilient and sustainable, providing the foundation for the later social and economic changes that lead to the development of urbanism.

Supplementary material

To view supplementary material for this article, please visit https://doi.org/10.15184/aqy.2024.32.

Acknowledgements

We thank the Leon Recanati Institute for Maritime Studies Maritime Workshop, led by Amir Yurman and Moshe Bachar, without whom this excavation could not have succeeded. Rami Tzadok and Tufik Bariah provided boating services. Olivia Ayers, Adellina Cini, Ghavin Deonarain, Chandler Houghtalin, Silvana Kreines, Sára Lantos, Alyssa Pietraszek, Nicolás Ramudo, Marko Runjajić and Tanya Sokolsky assisted in the excavation and post-excavation processing.

Funding Statement

This research was funded by the Koret Foundation (Grant no. 19-0295), aiming to support research collaborations focusing on marine archaeology between UC San Diego's Scripps Center for Marine Archaeology (SCMA) and the University of Haifa's Leon Recanati Institute for Maritime Studies (RIMS). Roey Nickelsberg is supported by a Haifa Center for Mediterranean History PhD Scholarship, the Nathan Rotenstreich Scholarship for outstanding PhD students in the humanities and the Sir Maurice and Lady Irene Hatter Research Grant from RIMS. Further funding was afforded by the Israel Science Foundation (Grant no. 697/20) granted to Ruth Shahack-Gross.

References

Arkin Shalev, E., R. Nickelsberg & A. Yasur-Landau. 2022. Neve Yam underwater survey. *Hadashot Arkheologiyot: Excavations and Surveys in Israel* 134. Available at: https://www.hadashot-esi.org.il/Report_Detail_Eng.aspx?id=26232&mag_id=134 (accessed 15 March 2023).

Badreshany, K. 2016. Lebanon's earliest potting traditions in regional context. *Berytus* 59: 5–42.

Banning, E.B. 1998. The Neolithic period: triumphs of architecture, agriculture, and art. *Near Eastern Archaeology* 61(4): 188–237. https://doi.org/10.2307/3210656

– 2019. It's a small world: work, family life and community in the Late Neolithic, in A. Yasur-Landau, E.H. Cline & Y.M. Rowan (ed.) *The social archaeology of the Levant from prehistory to the present*: 98–121. Cambridge: Cambridge University Press.

Bar, S. & D. Rosenberg. 2011. Newly discovered Yarmukian and Wadi Rabah sites in the southern Jordan Valley and the desert fringes of Samaria during the 7th and 6th millennia BC: preliminary report. *Archaeology, Ethnology and Anthropology of Eurasia* 39(3): 32–39. https://doi.org/10.1016/j.aeae.2011.11.002

Bar-Matthews, M., A. Ayalon, A. Kaufman & G.J. Wasserburg. 1999. The eastern Mediterranean paleoclimate as a reflection of regional events: Soreq Cave, Israel. *Earth and Planetary Science Letters* 166: 85–95. https://doi.org/10.1016/S0012-821X(98)00275-1

Bar-Yosef, O. & A. Mazar. 1982. Israeli archaeology. *World Archaeology* 13: 310–25.

Barkai, R. 2011. The evolution of Neolithic and Chalcolithic woodworking tools and the intensification of human production: axes, adzes, and chisels from the southern Levant, in M.R. Edmonds & R.V. Davis (ed.) *Stone axe studies III*: 39–54. Oxford: Oxbow.

Barkai, R. & R.W. Yerkes. 2008. Stone axes as cultural markers: technological, functional and

symbolic changes in bifacial tools during the transition from hunter-gatherers to sedentary agriculturalists in the southern Levant, in L. Longo & N. Skakun (ed.) *"Prehistoric technology" 40 years later: functional studies and the Russian legacy* (British Archaeological Reports International Series 1783): 159–68. Oxford: Archaeopress.

Barzilai, O. & N. Getzov. 2011. The 2010 excavation season at Mishmar Ha'emeq in the Jezreel Valley. *Neo-Lithics* 2/11: 17–20.

Biehl, P.F. & O.P. Nieuwenhuyse (ed.) 2016. *Climate and cultural change in prehistoric Europe and the Near East*. Albany: State University of New York Press.

Biehl, P.F. & E. Rosenstock (ed.) 2022. *6000 BC: transformation and change in the Near East and Europe*. Cambridge: Cambridge University Press.

Clarke, J. 2010. Contextualizing Neolithic Cyprus: preliminary investigations into connections between Cyprus and the Near East in the later Neolithic, in D. Bolger & L.C. Maguire (ed.) *The development of pre-state communities in the ancient Near East: studies in honour of Edgar Peltenburg:* 197–206. Oxford: Oxbow.

Danin, A. 2004. *Distribution atlas of plants in the Flora Palaestina area*. Jerusalem: The Israel Academy of Sciences and Humanities.

Dunand, M. 1973. *Fouilles de Byblos V*. Paris: Maisonneuve.

Flohr, P., D. Fleitmann, R. Matthews, W. Matthews & S. Black. 2016. Evidence of resilience to past climate change in Southwest Asia: early farming communities and the 9.2 and 8.2ka events. *Quaternary Science Reviews* 136: 23–39. https://doi.org/10.1016/j.quascirev.2015.06.022

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

Galili, E. *et al.* 1993. Atlit-Yam: a prehistoric site on the sea floor off the Israeli coast. *Journal of Field Archaeology* 20: 133–57.

Galili, E., L.K. Horwitz, V. Eshed & B. Rosen. 2017. Submerged Pottery Neolithic settlements off the coast of Israel: subsistence, material culture and the development of separate burial grounds, in G. Bailey, J. Harff & D. Sakellariou (ed.) *Under the sea: archaeology and palaeolandscapes of the continental shelf* (Coastal Research Library 20): 105–130. Cham: Springer. https://doi.org/10.1007/978-3-319-53160-1_7

– 2019. The "Israeli Model" for the detection, excavation and research of submerged prehistory. *TINA Maritime Archaeology Periodical* 10: 31–69.

Garfinkel, Y. 1993. The Yarmukian culture in Israel. *Paléorient* 19(1): 115–34.

– 2006. The social organization at Neolithic Sha'ar Hagolan: the nuclear family, the extended family and the community, in E.B. Banning & M. Chazan (ed.) *Domesticating space: construction, community, and cosmology in the late prehistoric Near East*: 103–111. Berlin: Ex Oriente.

– 2014. Incised pebbles and seals, in D. Rosenberg & Y. Garfinkel (ed.) *Sha'ar Hagolan, volume 4: the ground-stone industry: stone working at the dawn of pottery production in the southern Levant:* 205–34. Jerusalem: Israel Exploration Society.

Garfinkel Y. & D. Dag. 2008. *Neolithic Ashkelon* (Qedem 47). Jerusalem: The Hebrew University of Jerusalem.

Garfinkel, Y., D. Ben-Shlomo & N. Marom. 2012. Sha'ar Hagolan: a major Pottery Neolithic settlement and artistic center in the Jordan Valley. *Eurasian Prehistory* 8(1–2): 97–143.

Getzov, N. 1999. Hagoshrim. *Hadashot Arkheologiyot: Excavations and Surveys in Israel* 110: 2–3.

Getzov, N. *et al.* 2009. Nahal Betzet II and Ard el Samra: two late prehistoric sites and settlement patterns in the Akko Plain. *Journal of the Israel Prehistoric Society* 39: 81–158.

Gopher, A. & R. Barkai. 2012. *Village communities of the Pottery Neolithic period in the Menashe Hills, Israel, volume 3: archaeological investigations at the sites of Naḥal Zehora* (Monograph Series 29). Tel Aviv: Tel Aviv University, Sonia and Marco Nadler Institute of Archaeology.

Gopher, A. & E. Orrelle. 1996. An alternative interpretation for the material imagery of the Yarmukian, a Neolithic culture of the sixth millennium BC in the southern Levant. *Cambridge Archaeological Journal* 6: 255–79.

Goring-Morris, N. & A. Belfer-Cohen. 2020. Highlighting the PPNB in the southern Levant. *Neo-Lithics* 20: 3–22.

Hartmann-Shenkman, A., M.E. Kislev, E. Galili, Y. Melamed & E. Weiss. 2015. Invading a new niche: obligatory weeds at Neolithic Atlit-Yam, Israel. *Vegetation History and Archaeobotany* 24: 9–18. https://doi.org/10.1007/s00334-014-0498-3

Kafafi, Z.A. 2006. Domestic activities at the Neolithic site, 'Ain Ghazal, in E.B. Banning &

M. Chazan (ed.) *Domesticating space: construction, community, and cosmology in the late prehistoric Near East:* 81–89. Berlin: Ex Oriente.

Kaplan, J. 1972. The archaeology and history of Tel Aviv-Jaffa. *Biblical Archaeologist* 35(3): 66–95.

Kenyon, M.K. & T.A. Holland. 1982. *Excavations at Jericho, volume IV: the pottery type series and other finds*. London: British School of Archaeology in Jerusalem.

Kislev, M.E. & A. Hartmann. 2012. Food crops from Nahal Zehora II, in A. Gopher (ed.) *Village communities of the Pottery Neolithic period in the Menashe Hills, Israel, volume 3: archaeological investigations at the sites of Nahal Zehora* (Monograph Series 29): 1321–26. Tel Aviv: Tel Aviv University, Sonia and Marco Nadler Institute of Archaeology.

Kislev, M., A. Hartmann & E. Galili. 2004. Archaeobotanical and archaeoentomological evidence from a well at Atlit-Yam indicates colder, more humid climate on the Israeli coast during the PPNC period. *Journal of Archaeological Science* 31: 1301–10. https://doi.org/10.1016/j.jas.2004.02.010

Maher, L.A., E.B. Banning & M. Chazan. 2011. Oasis or mirage? Assessing the role of abrupt climate change in the prehistory of the southern Levant. *Cambridge Archaeological Journal* 21: 1–30. https://doi.org/10.1017/S0959774311000011

Matero, I.S.O., L.J. Gregoire, R.F. Ivanovic, J.C. Tindall & A.M. Haywood. 2017. The 8.2ka cooling event caused by Laurentide ice saddle collapse. *Earth and Planetary Science Letters* 473: 205–14. https://doi.org/10.1016/j.epsl.2017.06.011

Migowski, C., M. Stein, S. Prasad, J.F. Negendank & A. Agnon. 2006. Holocene climate variability and cultural evolution in the Near East from the Dead Sea sedimentary record. *Quaternary Research* 66: 421–31. https://doi.org/10.1016/j.yqres.2006.06.010

Nickelsberg, R., R. Shahack-Gross & A. Yasur-Landau. In press. The Early Bronze Age I coastal settlements of Israel: a new phenomenon or part of a long-lived settlement tradition?, in A. Yasur-Landau, G. Gambash & T.E. Levy (ed.) *Mediterranean resilience: collapse and adaptation in antique maritime societies*. Sheffield: Equinox.

Perrot, J. 1964. Les deux premières campagnes de fouilles a Munḥatta (1962–1963): premiers résultats. *Syria* 41(3–4): 323–45.

Perrot, J. & A. Gopher. 1996. A Late Neolithic site near Ashkelon. *Israel Exploration Journal* 46(3–4): 145–66.

Rollefson, G.O. 2020. The PPNC: like a bridge over troubled waters, in H. Khalaily, A. Re'em, J. Vardi & I. Milevski (ed.) *The project at Motza (Moẓa): the Neolithic and later occupations up to the 20th century*: 131–63. Jerusalem: Israel Antiquities Authority.

Rosenberg, D. 2010. Early maceheads in the southern Levant: a "Chalcolithic" hallmark in Neolithic context. *Journal of Field Archaeology* 35: 204–16. https://doi.org/10.1179/009346910X12707321520512

Rosenberg, D. & Y. Garfinkel. 2014. Discussion, in D. Rosenberg & Y. Garfinkel (ed.) *Sha'ar Hagolan, volume 4: the ground-stone industry: stone working at the dawn of pottery production in the southern Levant:* 205–34. Jerusalem: Israel Exploration Society.

Rosenberg, D. & A. Golani. 2012. Groundstone tools of a 'coppersmiths' community: understanding stone-related aspects of the Early Bronze Age site of Ashqelon Barnea. *Journal of Mediterranean Archaeology* 25: 27–51. https://doi.org/10.1558/jmea.v25i1.27

Roskin, J., Y. Asscher, H. Khalaily, O. Ackermann & J. Vardi. 2022. The palaeoenvironment and the environmental impact of the Pre-Pottery Neolithic Motza megasite and its surrounding Mediterranean landscape in the central Judean Highlands (Israel). *Mediterranean Geoscience Reviews* 4: 215–45. https://doi.org/10.1007/s42990-022-00076-x

Ryan, P. & A. Rosen. 2016. Managing risk through diversification in plant exploitation during the seventh millennium BC: the phytolith record at Çatalhöyük, in P.E. Biehl & O.P. Nieuwenhuyse (ed.) *Climate and cultural change in prehistoric Europe and the Near East* (IEMA Proceedings 6): 117–35. Albany: State University of New York Press.

Shea, J.J. 2013. *Stone tools in the Paleolithic and Neolithic Near East—a guide*. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9781139026314

Shochat, H., R. Yeshurun, D.E. Friesem, D. Kaufman, N. Porat, A.M. Rosen & D. Nadel. 2019. The Neolithic occupations of Neve David, Mount Carmel, Israel. *Mitekufat*

Haeven: Journal of the Israel Prehistoric Society 49: 152–89.

Simmons, A.H. 1994. Early Neolithic settlement in western Cyprus: preliminary report on the 1992–1993 test excavations at Kholetria Ortos. *Bulletin of the American Schools of Oriental Research* 295. https://doi.org/10.2307/1357101

Stekelis, M. 1950. A new Neolithic industry: the Yarmukian of Palestine. *Israel Exploration Journal* 1(1): 1–19.

Twiss, K.C. 2007. The Neolithic of the southern Levant. *Evolutionary Anthropology: Issues, News, and Reviews* 16: 24–35. https://doi.org/10.1002/evan.20113

Weninger, B. *et al*. 2006. Climate forcing due to the 8200 cal yr BP event observed at early Neolithic sites in the eastern Mediterranean. *Quaternary Research* 66: 401–20. https://doi.org/10.1016/j.yqres.2006.06.009

Yasur-Landau, A. 2019. The archaeology of maritime adaptation, in A. Yasur-Landau, E.H. Cline & Y.M. Rowan (ed.) *The social archaeology of the Levant from prehistory to the present*: 551–70. Cambridge: Cambridge University Press.