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The Garbage Crisis in prehistory: artefact discard patterns at the Early Natufian site of Wadi Hammeh 27 and the origins of household refuse disposal strategies

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Abstract

Concepts of refuse behavior and site abandonment have been developed that show potential to distinguish degrees of mobility and sedentism among past human communities. Whereas much of this work had been conducted in ethnographic situations or on recent sites, this study makes an initial attempt to apply this body of theory to the archaeological record of humanity's most fundamental settlement transition: from mobile hunter-gatherer to settled village farmer. The centerpiece of the study is an analysis of artefact distribution patterns in the Natufian site of Wadi Hammeh 27 (ca. 12,000 years BP), which is combined with a diachronic overview of data from earlier and later sites, dating from 20,000 to 8000 years BP. We conclude that human communities in the Natufian period had not yet tailored their indifferent household refuse disposal practices to the long-term requirements of sedentary living. Subsequently, there occurs a punctuated gradient of change in the Levantine sequence, towards higher rates of secondary refuse disposal. Elementary efforts at refuse disposal begin in the Pre-Pottery Neolithic A period (ca. 10,300–9200 years BP), and some form of consistent garbage cycling was probably a standard feature in many villages by the Pre-Pottery Neolithic B period (ca. 9200–8000 years BP).

Keywords: Garbage; Refuse behavior; Site abandonment; Sedentism; Natufian; Pre-Pottery Neolithic; Levant; Jordan

In the late third millennium BC, residents of the small Jordan Valley farming hamlet of Tell el-Hayyat disposed of their household rubbish by tipping it into the narrow lanes that ran between their cramped mud-brick dwellings (Falconer, 1995). By modern urban standards this represents an indifferent effort at domestic sanitation, but it was, nonetheless, a systematic strategy for refuse management. In comparison, evidence for refuse disposal is almost entirely lacking from the interior of the modest huts at the 12,000 year-old site of Wadi Hammeh 27, located only 5 km away in the foothills of the Jordan Valley (Fig. 1). In this paper we contend that initial strategies of household refuse management were developed between these distant periods, and that the most pressing sanitation problems of village life had been addressed by the Pre-Pottery Neolithic B (PPNB) period (ca. 9200–8000 years BP).

The centerpiece of this paper is the site of Wadi Hammeh 27, which dates to the southern Levant's Early Natufian period (ca. 13,000–10,300 years BP; Weinstein-Evron, 1998, p. 72–78). The larger Natufian sites are regarded as transitional between the mobile hunter-gatherer communities of the earlier Epipalaeolithic (ca. 20,000–13,000 years BP) and the sedentary agrarian villagers of the Pre-Pottery Neolithic A (PPNA, 10,300–9200 years BP) and the Pre-Pottery Neolithic B (PPNB,

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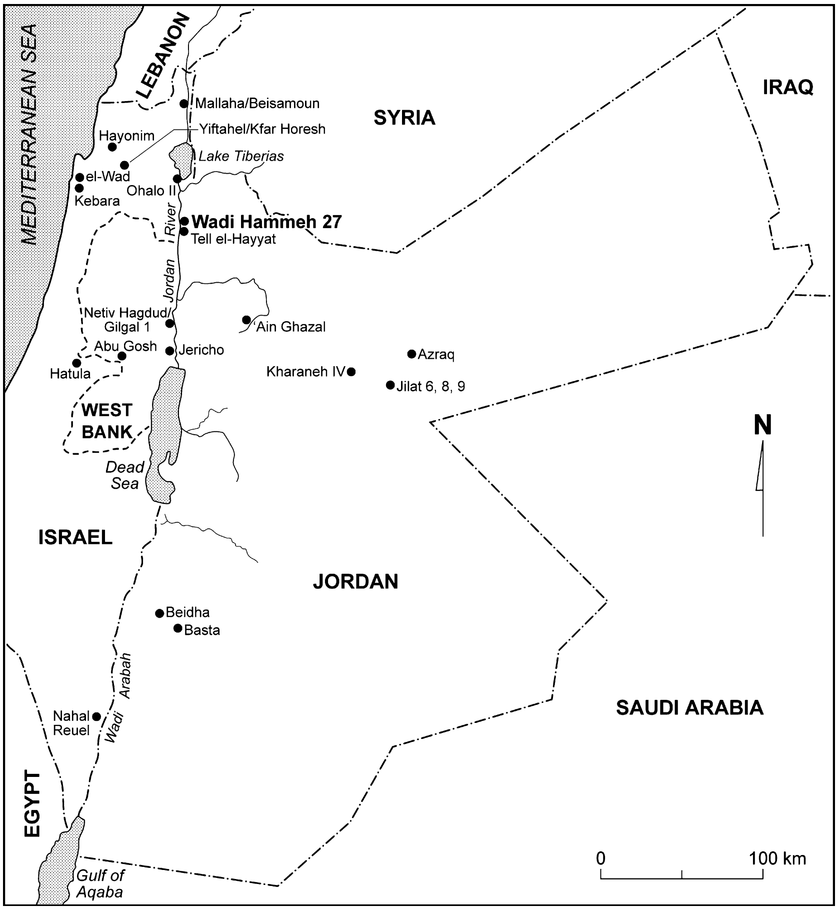


Fig. 1. Location of Wadi Hammeh 27 and other southern Levantine sites mentioned in the text.

9200–8000 years BP) periods (Bar-Yosef, 1998). Here, we propose that Natufian period hunter-gatherers who resided in the Levant's earliest agglomerations of curvilinear stone dwellings lacked systematic practices of refuse disposal. Prodigious quantities of primary refuse, which include by-products of artefact manufacture and animal bone scraps, have been found discarded in these settlements, commingled with cached items of equipment, and even human remains. They provide graphic illustrations of the view expressed by Rathje and Murphy (1992, p. 32) who noted that "Throughout most of time human beings disposed of garbage in a very convenient manner: simply by leaving it where it fell." By the PPNB period however, sedentary villagers across the Middle East who occupied large (up to 15-hectare) settlements of closely spaced rectilinear stone and mudbrick houses, routinely maintained their dwellings clean from significant accumulations of refuse. Rathje and Murphy (1992, p. 33) encapsulate the phenomenon by their summation (from which we borrow our title): "As such habits suggest, our species faced its first garbage crisis when human beings became sedentary animals."

Artefact distributions and the earliest sedentary societies

Hayden and Cannon (1983, p. 117) observed that the subjects of artefact patterning and refuse discard have provoked considerable interest among archaeologists. They note the obvious relevance of refuse to archaeologists, for the drawing of demographic, economic, social or behavioral inferences about past human communities. Many of the pioneering (Baker, 1975; Lange and Rydberg, 1972; Rathje, 1974; Schiffer, 1972, 1976) and later (e.g., Cameron and Tomka, 1993) studies of artefact discard, refuse disposal, and site abandonment focused on ethnographic case studies in order to relate archaeological statics to behavioral dynamics (as encouraged by Binford, 1983).

Less attention has been directed to refuse disposal strategies of human communities during the terminal Pleistocene and early Holocene in the Levant, although these periods witnessed humanity's most fundamental settlement transition, from mobile hunter-gatherer to settled village farmer. Tomka (1993a) for example, in *Abandonment of settlements and regions*, summarizes several issues arising from the works in the volume, but not those concerning the earliest sedentary societies. Discussion about the origins of sedentary life in the Levant has hitherto centered on several evidential classes including settlement patterns, architectural structures, artefact types, and faunal and botanical remains. Yet the regional issue of refuse and lifestyle has not yet benefited much from explicit discussion within the theoretical framework of the literature on site abandonment and refuse disposal, despite pioneering studies into artefact distribution patterns, especially in the Late Epipalaeolithic period, by many scholars such as Belfer-Cohen (1988), Cauvin and Coquegniot (1988); Goring-Morris (1988), Marks and Larson (1977), and Valla (1988, 1991).

No doubt, the sheer scale of the large Neolithic sites has hitherto impeded the implementation of such analyses for later periods. For the PPNA, there is Nadel's (1997) detailed analysis on artefact densities from various contexts at Netiv Hagdud; and for the later PPNB-equivalent period in Turkey, Martin and Russell (2000) have produced a highly considered theoretical exploration of discard at Çatalhöyük. However, for the pre- to early agrarian periods in the Levant, little effort has been made towards the integration of artefact distributions with the considerable corpus of refuse and abandonment theory that has accumulated, and as François Valla has noted (1991: 111):

> S'il est vrai, comme J. Perrot le pense depuis trente ans, que les Natoufiens aient été les premiers sédentaires au Levant, leur relation à l'espace est un des problémes les plus importants qu'ils nous posent.

> If it is true, as J. Perrot thought thirty years ago, that the Natufians were the first sedentary communities of the Levant, then their relation to space is one of the most important problems that we can investigate (translation by PCE).

In this paper we contend that the data from Wadi Hammeh 27 hold implications for the issue of the earliest sedentary societies in the Natufian period, and that similar evidence from earlier, contemporaneous and later sites support the idea that a solution to the 'garbage crisis' was developed sometime between 12–11,000 and 9–8000 years BP during the long transition when communities took initial steps in solving the problems of maintaining long-term residencies in cramped and littered villages.

Abandonment theory, refuse disposal, and residential longevity

Ethnoarchaeological studies have enabled linkages to be made between residential strategies and discard behavior. As Kent (1993, p. 66) noted, a cardinal goal in such work has been to develop different models of abandonment behavior for "nomadic, semi-sedentary, and sedentary groups." Since the degree of sedentism for the Natufian is taken in this exercise as an unknown factor, we rely on robust correlations between ethnographically known communities of varying levels of residential stability and their material residues in order to provide insights into levels of mobility in the Natufian period. Several categories of refuse have been defined, largely emanating from the work of Schiffer (1972, 1976, p. 30, 33). While they are well known, we review them here since they are important in this discussion.

Primary refuse refers to the intentional discard of items at or near the end of their use-life, in their location of use. *Secondary refuse* is the discard of items in areas other than where they were used. *De facto refuse* "consists of the tools, facilities and other cultural materials that, although still usable, are abandoned with an activity area" (Schiffer, 1976, p. 33). *Provisional discards*—items with potential value or large hindrance value, are usually stored in out-of-the-way places, e.g., along walls (Deal, 1985; Hayden and Cannon, 1983; Joyce and Johannessen, 1993, p. 329). *Abandonment refuse* is a term sometimes used to describe the condition of primary or secondary refuse prior to and during site abandonment.

Martin and Russell (2000, p. 57) suggest that these kind of typological categorizations (which can be considered as *etic* notions drawn up by archaeological observers) reflect an unconsidered processual approach to archaeology, which seeks to advance "discard as a universal human activity that confirms to a uniform set of rules." Rather, they advance a post-processual stance in order to try to penetrate the community standards driving neolithic discard behavior at Çatalhöyük, (or *emic* notions developed by the past community under study). This, of course, encapsulates a dichotomy of approach that has preoccupied archaeology for the past 20 years, just as it did in the discipline of history for many decades previous to that. Before such concerns became prominent in archaeology, Geertz (1979) had demonstrated the methodological flaws in trying to discover the internal community rules of the ethnographic subject (let alone those of a people long vanished) just as Carr (1987) did for the subjects of historical interrogation (*contra.* Collingwood, 1946). Thus, Martin and Russell (2000, p. 58) subsequently allow that they need to use conventional archaeological descriptors of archeological discards, and monitor "repeated associations and regulations of placement of materials" in order to pursue their aims of discovering internal social rules. But the descriptors of 'abandonment' theory meet these very aims, and we cannot see a profitable way to penetrate the 'palaeo-psychology' of long-vanished human communities. We can agree with Martin and Russell, that one should not pre-judge the meanings that archaeological discard categories held for their producers (for example clean versus unclean). Indeed, we make recourse to the ethnographic record and some unusually tolerant attitudes to food refuse and malodorous organic remains below, in trying to imagine what appear as similar, non-normative attitudes, prevalent in the Natufian period.

Because we have been critical of post-processual archaeology, it does not follow that we must be processual archaeologists. We feel the need to emphasize the point because it seems to us that a belief that one must fall into one camp or the other still lingers. While, like Rensink (1995), we believe we have no way out of giving meaning to our etically categorized data than through illuminating them with ethnographic parallels, we do so here in order to highlight the shortcomings (i.e., 'falsify') of faulty or simplistic models of social action, rather than to inadequately affirm hypotheses according to the naïve logical-positivist method advocated by the original New Archaeologists (Gibbon, 1989). Thus, we use the Nootka ethnographic example below for limited ends, to provide contrary (i.e., falsifying) cases to the simple notion that communities who are sedentary, or long-term occupants of a site, must practice elaborate refuse disposal behavior.

We echo Coudart's (1998, 1999) bafflement over the continuing popularity of 'processual' and 'post-processual' approaches in Anglophone archaeology; the former with its flawed methodological core; the latter crowding so many disparate voices under its banner as to lack a coherent core at all. We highlight our remoteness from processualism because we do indeed concentrate in this paper on topics dear to processualist researchers, such as ethnographic analogy, and broadly based cultural trends. We wish to make clear that we are not here espousing cultural laws, or law-like generalizations that orient human social behavior. Well before this agenda was taken up by the first generation of processual archaeologists, Popper (1957), in his penetrating analysis, had delivered a comprehensive repudiation of the concept that human behavior can be encapsulated by absolute trends or universal law-like generalizations. We do believe that the diachronic generalizations we make about the archaeological sequence for the prehistoric Levant are supported robustly by the empirical record; they are trends but not thus absolute trends. The behaviors they mirror depended on particular sets of historical circumstances and unique initial social and environmental conditions to come into being.

To date, ethnographic have revealed general trends about the ways in which modern peoples produce different categories of refuse, and how these behaviors relate to residential mobility. Primary refuse is particularly linked with mobile hunter-gatherers and short-term residential stays, usually a few days at a time (Binford, 1978; Murray, 1980; O'Connell, 1987). For Kutse hunter-gatherer communities in the Kalahari Desert of southern Africa, Kent (1993, pp. 55–56) showed that shorter occupations led to smaller, less diverse artefact inventories than those resulting from longer residential visits. Short visits also result in less effort undertaken in site construction, less architectural permanence, and comparatively low visibility in the archaeological record. Highly mobile people like the Kutse tend not to store or move heavy gear very much, since it is readily available at a number of deserted settlements (Kent, 1993, p. 63). Kent (1999) also observed that secondary refuse deposits in Kutse camps contained less varied inventories than primary ones. It is natural to assume that secondary refuse deposits will be located away from, or at least outside of, residential dwellings, but this is not necessarily the case, so Kent's elucidation of additional characteristics of secondary refuse deposits is useful.

On the other hand, several studies undertaken on both sedentary and semi-sedentary agriculturists highlighted the fact that "primary refuse appears usually to be a relatively insignificant process" (Joyce and Johannessen, 1993, pp. 138–139). As residential stays lengthen, relocation of refuse to secondary dumps, storage of equipment for future visits (Stevenson, 1982, p. 253; Tomka, 1993b, p. 24), and curation of artefacts upon site abandonment loom as important factors. Among the semi-mobile Rarámuri, an agro-pastoralist people of southern Mexico, Graham (1993, p. 39) observed that in "residential structures, householders tend to keep activity areas clear of objects that impede the flow of activities or occupy usable space." Increased formalization in the use and maintenance of space for separate activities is correlated with increased efforts in keeping the house clear of accumulated materials.

Aside from the actual length of residential stays, anticipated length of occupation has proved to be an important variable in conditioning refuse disposal, with gradual, planned abandonment and anticipated return resulting in high levels of de facto refuse, including numerous cached items (Stevenson, 1982). From the American Southwest, Schlanger and Wilshusen (1993, p. 90) also provided an example of anticipated return being directly proportional to large sizes of material inventories. In general, sites abandoned in a gradual but planned manner tend to produce abundant de facto refuse, whereas sites that are abandoned with little forethought (other than in the case of unforeseen natural disasters) produce less abundant refuse, including primary refuse (Stevenson, 1982, p. 248). Where people are intending to return to a site, primary refuse in structures is kept under control, but less care is taken if permanent abandonment is on the cards, so that primary refuse begins to accrete on floors and along thoroughfares (Graham, 1993, p. 37–38). For example at the rural Mexican settlement of La Concha, where primary 'abandonment refuse' accrued, there were still clearly defined areas set aside for secondary refuse in the form of nearby middens (Joyce and Johannessen, 1993, p. 148).

Montgomery (1993, p. 157) cautioned that such consensual ethnoarchaeological cases need not span the range of past abandonment behaviors evident in the archaeological record. Indeed, our main point here is that they do not really fit the Natufian period. It is difficult to find any modern parallels to the Natufian context, in terms of the colossal scale of primary and de facto refuse (including human remains) amalgamated on its hut floors. It is notable that in most ethnohistoric cases—except in uncommon cases such as the Joint Site (Schiffer, 1972) where flaked stone tools were made—that the actual numbers of artefacts under consideration tend to be small. This situation contrasts with many of the large Natufian sites, where artefact numbers measure in the hundred of thousands. Accepting that all forms of reflection between past archaeology and present ethnography involve the process of analogical reasoning (Wylie, 1985), it is within such anomalous situations such as the Natufian, which do not really fit within the range of ethnographic experience, that much interest lies (Gould, 1980). For example, Stevenson (1982, p. 262) mentions different cultural attitudes to refuse disposal that might lead to different archaeological scenarios. One scenario to consider for the Natufian period is that the notion of refuse disposal was rudimentary, and efforts at the removal of cultural debris to secondary contexts remained desultory at best.

The Natufian period and the issue of early sedentism

The linkage between refuse disposal practices and residential occupations leads us to the contentious issue of sedentism in the Natufian period. Based on his excavations at Mallaha in Upper Galilee, Perrot (1960, p. 21–22) first postulated that Natufian settlements corresponded to communities of sedentary hunter-gatherers, thereby establishing an influential paradigm for subsequent research. The discovery of these so-called Natufian base-camps (Bar-Yosef, 1970, pp. 172–178) added a new dimension to our understanding of innovations in human settlement and subsistence practices in the terminal Pleistocene. Since then, Wadi Hammeh 27 is only the third major open-air Early Natufian base-camp, after Mallaha and Jericho, to be excavated in the so-called 'core Natufian area' of the southern Levant (essentially Mount Carmel, the Galilee and the Jordan Valley, cf. Valla, 1998a). If, as Perrot argued, the larger Natufian sites represented sedentary hunter-gatherer communities, than this realization carried profound implications for the debate about the causes of agricultural societies in the early Holocene, since it implied that sedentism could precede the advent of food production (Binford, 1968, p. 334).

Subsequently other researchers argued the case for the Natufian open sites as settlements of sedentary peoples (Bar-Yosef and Kislev, 1989; Henry, 1985; Tchernov, 1984). Edwards (1989) questioned the straightforward attribution of perennial sedentism to the larger Natufian sites, where sedentism was interpreted as meaning only year-on-year, perennial settlement residence; that is, as if Natufian hunter-gatherers radiated from their abodes on a more-or-less permanent basis upon the food quest, in the manner of traditional agrarian villagers. A key theme of this analysis was to emphasize the questionable evidential yardsticks by which sedentism is gauged in the archaeological record. In addition, strong reservations were held about the plausibility of sustaining a hunting and gathering mode of existence based on continuous occupation of one residential locale, particularly in the brittle environment of the southern Levant. Since that issue was raised, more finely nuanced views have been developed (Bar-Yosef and Rocek, 1998; Liebermann, 1998; Valla, 1998b), in recognition of the numerous recent studies that have underlined the residential versatility of agriculturalists (e.g. Graham, 1993; Joyce and Johannessen, 1993) as well as hunter-gatherers.

Much effort has continued to be expended in fashioning more reliable archaeometrical yardsticks for seasonality and sedentism. For example, Tchernov (1984, 1991) proposed that increased numbers of human commensals such as mice and sparrows in Natufian sites equated with human sedentism. Tchernov also proposed the appearance of diagnostic new rodent sub-species with Natufian sedentism. Natufian sites undoubtedly contained large quantities of refuse which would have attracted commensals, but at issue is the extent to which the deposits containing the commensals' remains represent continuously deposited sediments throughout the course of a year—or else a considerable part of the yearly cycle—or whether they result from accumulations of long seasonal deposits (Edwards, 1989; Tangri and Wyncoll, 1989). Another approach to the problem was the development of methods for distinguishing season of death by identifying the seasonal accretion of cementum in the teeth of ungulate herd animals, and thus the season in which they were incorporated into archaeological deposits (Lieberman, 1993).

Despite the ambiguity over the interpretation of Natufian residential strategies, there is a consensus that the Natufian complex represents the transition to a settlement system involving comparatively longer residential occupancies than those of previous periods. Several studies have developed more subtle models of Natufian settlement involving elements of sedentariness, transhumance and mobility (Byrd, 1989; Bar-Yosef and Belfer-Cohen, 1992, pp. 24–25; Valla, 1990), and posited a variety of possible settlement scenarios (Perlès and Phillips, 1991). Most commonly advanced is a model of long, wet-season (winter) base-camp occupation followed by dry-season abandonment of the home base in favor of short or long-range foraging, whether this be in a circulating or radiating fashion (Bar-Yosef and Belfer-Cohen, 1989, pp. 450–451, 487; Henry, 1995, pp. 328–330; Perlès and Phillips, 1991). Arguing from the evidence of seasonal indicators amongst gazelle fauna, Davis (1983) suggested that several Galilee-Mount Carmel Natufian sites appeared to be winter encampments, but noted that no evidence of corresponding summer occupation sites were to be found.

Other scenarios position the larger Natufian sites as sedentary base-camps from which forays were launched, in a radiating fashion, for food and other resources (Moore et al., 2001, pp. 481–488). This foraging pattern necessitates the existence of a series of more ephemeral special-purpose camps (e.g., Henry, 1989, p. 219), but in truth, such a settlement pattern of ephemeral stations focused on a large base-camp remains elusive for the Natufian after some 80 years of research. One is hard-pressed to relate any small Natufian site to any particular larger one (as discussed by Davis, 1983; Henry, 1989, p. 219). In this regard it is all the more provocative that the small Natufian site of Wadi Khawwan 1 lies only 2 km to the southwest of Wadi Hammeh 27. In this case, however, all indications are that Wadi Khawwan 1 is several centuries later in date than the abandonment of the latter site (Edwards et al., 1998).

One of the most detailed models of sedentary occupation for the equivalent Syrian period to the Natufian has been advanced by Moore et al. (2001, pp. 481–488) for Abu Hureyra. Moore argues that the year-round availability of food resources enabled the site to persist through the seasons and across the years. We find these attributions problematic from the standpoint of the temporal perspective from which we envision archaeological sites. Food resources, which are available year-round, and which are found in archaeological sites, cannot of themselves demonstrate annual human sedentism, except in the unusual cases where occupation surfaces can be delimited according to seasonal or annual accumulations of sediment. These sorts of sedimentilogical conditions, which obtain in varved lacustrine sediments, are only found archaeologically under circumstances of exceptional preservation. In the Levant, perhaps they are attained solely in the lakeside Epipalaeolithic site of Ohalo II (ca. 19,500 BP), where lacustrine inundations are intercalated between very thin hut-floor layers (Tsatskin and Nadel, 2003).

Discussions of residential scheduling in the Natufian have repeatedly failed to acknowledge the long-term timespans (years, decades, and centuries) through which bones or plant remains may become incorporated into terrestrial sediments, (which are then modified by significant post-depositional processes), and which ultimately become manifest as single archaeological layers. These concerns, incidentally, go well beyond this regional case to form one of the most pressing current archaeological issues, about the time resolution of archaeological deposits (Bailey, 1981; Bailey, 1987; Murray, 1999; Stern, 1993).

From such a 'time perspectivist' view, consider the following statement: made with reference to the Natufian site of 'Ain Mallaha: "... the remains of certain migratory birds indicate an occupation of at least 10 months (September through July) every year" (Belfer-Cohen, 1991: emphasis added). But since the deposits of Mallaha, like other Natufian sites, cannot be temporally resolved below the error terms of radiocarbon dates (in the order of decades to centuries) there is no need for the various bird species present there to have been hunted every year, but rather sporadically, and intermittently during various occupations, whether during the migratory periods of spring or autumn, or during the periods when other species overwinter on the lake (Pichon, 1987). Further, gazelle was the major prey species at Mallaha (Bouchud, 1987) just as at Wadi Hammeh 27, and is endemic in the region throughout the year, implying the site might have been visited at various times, with intermittent taking of seasonal prey on certain occasions.

Like Mallaha, Wadi Hammeh 27 has yielded a broad range of animal and plant food resources which could arguably be adduced to attest to spring, autumn, early summer, and winter occupation (Edwards, 1991). Despite the fact that winter occupation of Wadi al-Hammeh in the terminal Pleistocene would have been amenable and summer occupation somewhat more arduous (Edwards, 1989) we do not see that the seasonality of resources from the site denote an unequivocal signal for winter occupation. Thus, the remains of barley, not to mention the impressive array of hafted sickles at the ready, attest to early summer occupation; migratory bird remains such as White Stork (*Ciconia ciconia*) point to spring or autumn occupation, and ducks (*Anas* sp.) may allude to winter occupation; whereas the major prey species of gazelle may have been taken at any time of the year. Whether Wadi Hammeh 27 was an annually sedentary site, or not, remains an open question (Edwards, 1989), but it remains incumbent on us to compare our conclusions drawn from the viewpoint of refuse behavior to the prevailing model of long-term winter base-camps and ephemeral dry-season camps, and this we attempt to do in the conclusion.

Archaeologically, investiture of corporate energy in the large Natufian sites is discernible in the form of architectural units maintained over long periods, in stratigraphic evidence for repeated occupations, human burials which have undergone elaborate attention and lengthy mortuary rituals, richly varied artefact assemblages, the stockpiling of heavy tools, and a wide variety of art and symbolic objects.

The fact that these archaeometrical indicators do not all pull in the same direction underlines their problematic status as correlates of human sedentism. The Wadi Hammeh 27 artefact distributions hint at some level of Natufian mobility, judging by the range of available ethnographic examples, although these do not in fact provide very close structural parallels. In fact, Wadi Hammeh 27 presents a complex archaeological array of refuse abandonment strategies, combining primary and occasional secondary discards intermingled with deliberately stored (de facto) equipment, and evidence for planned site abandonment and reoccupation. In order to provide the context for these interpretations, the following sections provide more details about Wadi Hammeh 27 and its environs.

Wadi Hammeh 27: context and site description

A broad area ($351.5\,m^2$) was excavated at Wadi Hammeh 27 between 1983 and 1990 (Fig. 2) in an effort to maximize horizontal exposure of the site's upper constructional phase (Edwards, 1991; Edwards and Churcher, 1993). The surviving part of Wadi Hammeh 27 comprises four superimposed architectural phases disposed over the surviving portion of the site (an area of about $2000\,m^2$). The site lies across the top of a steep-sided interfluvial ridge in Wadi al-Hammeh, a tributary of the Jordan Valley that debouches into the eastern rift opposite Beisan; much of the site has eroded from the ridge's northern and western margins. At present the perennial hot spring of Hammamat Abu Dhabla feeds Wadi al-Hammeh. The modern spring is a much smaller version of systems which have been variously active in the locale for several hundred thousand years (Macumber, 1992; Macumber and Head, 1991). The site's occupation layers are underlain by human burials (Webb and Edwards, 2002) and the site has yielded a rich artefactual repertoire that includes large-scale and small-scale rock art, tools of flint, limestone and basalt, and tools and ornaments of bone. There are also red and yellow ochre pigments, marine Dentalium shells for bead manufacture, diverse faunal remains, and an array of botanical remains.

Phytogeographically, Wadi al-Hammeh lies in an ecotonal position, just within the Irano-Turanian steppic province that stretches along the Jordan Valley, near the interface with the strip of Mediterranean forest that stretches along the Jordanian Plateau above the Rift Valley margins (Zohary, 1973, p. 167; Willcox, 1992, pp. 253–254).

Rainfall at Pella oscillates widely around an annual range of 300–400 mm (Bender, 1974, p. 12). Wadi al-Hammeh was an attractive locale for human occupation

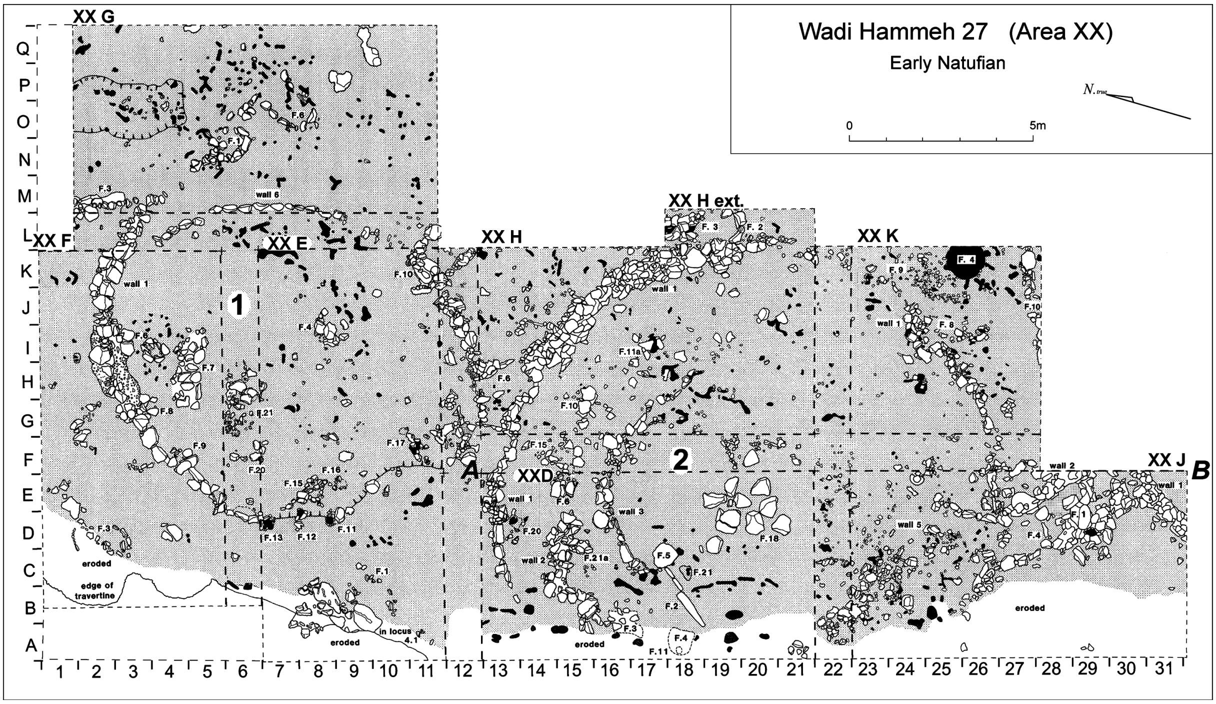


Fig. 2. Plan of Wadi Hammeh 27, Phase 1. Light gray shading = Phase 1 occupation surface. Dark shading indicates biogenic cavities and anthropogenic features, the latter being limited to stone-ringed postholes and pits (Features 4, 11, 12, 13, and 17). Discs A and B indicate the stratigraphic section illustrated in Fig. 3.

in the Late Pleistocene as the continuous expanses of archaeological finds through time attest. Throughout, the low altitudes of the valley would have scarcely been uncomfortably cold nor would water have been short. Wadi Hammeh 27 would have commanded impressive views to the west over Lake Lisan (Macumber and Head, 1991), and remained in propinquity to the higher-altitude open forests and the associated cereals and legumes of the forest margins.

The most relevant palaeoenvironmental data to Wadi al-Hammeh comes from the nearby Lake Huleh pollen core in northern Galilee (Baruch and Bottema, 1999) which indicates that reasonably moist conditions prevailed in the southern Levant between 15,000 and 11,500 BP, during which time Wadi Hammeh 27 was occupied. Indeed, these conditions represented the most favorable situation for human habitation since the Late Glacial Maximum, and saw an expansion of open Mediterranean forest tree species with their attendant understorey, including economically useful cereals and legumes. *Quercus* sp. (Oak) was recovered from the floated samples from Wadi Hammeh 27 along with other Mediterranean taxa such as wild barley (*Hordeum spontaneum*), goat-face grass (*Aegilops*), pistachio, lentil, and several weeds which inhabit disturbed ground (Colledge, 1994, pp. 160–161). Wadi Hammeh 27 faunal remains represented a broad range of taxa including Red Deer, Roe Deer, Fallow Deer, aurochs, wild boar, equids, sheep/goat, gazelle, and a number of birds. The faunal diversity indicates the presence of a complex of marsh, open forest, craggy, and steppic habitats in close proximity to the site (Garrard, n.d).

Wadi Hammeh 27: stratigraphy and settlement

Wadi Hammeh 27 is directly underlain by 3 m of culturally sterile travertines and silts. The circumstance of the site being grounded on bedrock and covered by relatively thin deposits of silts and topsoil rendered it a logistically straightforward proposition to excavate over broad areas. Minimal clearance of overlying deposits was necessary, and at the site's northern end, wall tops protruded through the surface before excavation. The major sediment contributors were dark gray clays and silts deposited in the terminal Pleistocene by massive groundwater springs located immediately upstream of the site. After the final abandonment of the site, slow rates of sedimentation continued until 11,000 years BP, as attested by the carbon date of $11{,}100 \pm 120$ years BP (ANU—120) gained from freshwater *Melanopsis* shells embedded in surficial deposits that cap approximately a meter of silts overlaying the cultural remains (Macumber and Head, 1991). In cliff section it can be seen that the Natufian cultural deposits reach a maximum thickness of about 3 m, though bedrock was reached at 1.2 m below the surface in the northern area of the site (Plot XX F).

Vertical extent of occupation at Wadi Hammeh 27

Four superimposed constructional phases, designated Phase 1 to Phase 4 from youngest to oldest, were exposed in a sondage located in Plot XX F (Fig. 4). The sediments throughout all phases exhibited little color change but were distinguishable clearly by sediment compaction. Earthen or bedrock floors are correlated with each phase of architectural features.

Below the broad exposure of Phase 1 excavated in Plot XX F, the XX F sondage revealed Phase 2 to consist of a gray clay floor of variable hardness, associated with a section of curvilinear stone wall (F.5, Fig. 4A). Feature 5 underlies Structure 1's Wall 1 in Phase 1, and follows the same curvature. A cluster of stones topped by a cup-shaped limestone mortar (F.4) was also laid on the floor of Phase 2. The cup-shaped mortar, being the uppermost member of F.4, was first encountered protruding through the floor of the overlying Phase 1. The underlying Phase 3 surface consisted of clay and detritus trampled into depressions in the existing deposits of travertine, forming a roughly horizontal floor (Fig. 4B). A number of features were dug into or placed on this surface, including a circular hearth bordered by stones (F.12). A large rock bordering this stone circle to the west formed the base for the little stone pillar (F.4), which continued to be augmented upwards through Phases 2 and 1.

Phase 4, underlying Phase 3, comprised deposits and features associated with a human burial cut into the travertine bedrock The stone-ringed hearth (F.12) of Phase 3 was laid directly over a pit (F.16) in Phase 4 that was capped with stone rubble (Fig. 4C). This was an intriguing feature, in that the cap-rock surmounted a dark humic deposit liberally sprinkled with burnt flaked stone artefacts and bone fragments. Below this was a second layer of rubble capping a second layer of dark sediment, the whole resting on a third rubble layer resting on the bottom of the pit. Next to this was an oval pit (F.8, Fig. 4D), dug into the travertine basement, which contained a primary human burial (Webb and Edwards, 2002).

Planned abandonment and reoccupation of Wadi Hammeh 27

The reconstruction of architectural features through Phases 1–4 attests to the planned abandonment and reoccupation of Wadi Hammeh 27. For example, the wall (F.5) built on the Phase 2 floor was rebuilt along the same lines in Phase 1; the stone-ringed hearth (F.12) was laid directly above the three-phase rubble-sealed pit situated below it. The cup mortar, being the uppermost member of F.4 in Phase 2, was first encountered protruding through the Phase 1 floor. Given the spatial proximity and stratigraphic conformability of these features, it is likely that they were rebuilt to mark the position of the grave. Such evidence indicates that the site was rebuilt with regard shown for earlier features, and that the successive constructions represent several generations of occupation.

Description of Wadi Hammeh 27, Phase 1

Our analyses of artefact distributions concern the uppermost Phase 1 (Fig. 2). Phase 1 is dated by three AMS radiocarbon determinations of $11,920 \pm 150$ years (OxA-393), $11,950 \pm 160$ years BP (OxA-507), and $12,200 \pm 160$ years BP (OxA-394) obtained from charred seeds (Edwards, 1987, p. 134). Considerable amounts of deposits have slumped from the Plateau cliff (indicated by the white area in Fig. 2), thereby truncating Structure 2 to the west. Numerous other features, artefacts and even human burials are exposed along the western cliff line over a distance of seventy meters. Two small excavation pits (Plots XX M and XX N) were also placed peripherally, to the east and south of the main excavation area in order to gauge the characteristics of the site near its margins.

The Phase 1 excavations revealed two large curvilinear stone structures (Structure 1 and Structure 2). Structure 1 is an oval stone structure opening to the south-west, with the entrance marked by an arc of postholes. Structure 2 is a more complex arrangement, comprising three concentric walls set around a central pile of large limestone boulders. The two structures are essentially freestanding units, although they are set close together, and are at one point directly linked by a short and insubstantial wall segment (F.6). Walls were dry-built of undressed limestone blocks and fragments, with the sporadic addition of siltstone, travertine, and recycled ground stone artefacts. Occasionally a few stones were set into a mud mortar. Both structures have sunken interiors set down about 30 cm from the exterior. This was achieved by laying wall stones against a pre-cut step and thereby forming a terrace wall. Each perimeter wall had attached to it a series of smaller freestanding stone features, hearths, and pits.

The Phase 1 occupation surfaces formed a simple trilogy consisting of topsoil, calcareous subsoils, and rich, dark occupation deposits. The occupation deposits comprise a 30-cm thick, brownish-black to dark gray humic clay layer covering the floors. The floor layers were not constructed in a deliberate sense, but were comprised of compacted cultural sediments, of similar type to the overlaying ones. The floors are composed entirely of pre-existing occupation deposits (save for the lowermost floor or occupation surface based on bedrock) and each one exists essentially as a stratigraphic interface only.

Several lines of evidence satisfied us that there were no additional floor surfaces which had been missed on the way down, and enabled the isolation of a continuous occupation surface over the entirety of Phase I. First, the Phase 1 floor surfaces were more compacted compared to the overlying matrix, and the latter deposits tended to cleave off neatly at the interface with the floors. Second, the floor levels were usually slightly different in color than the overlying matrix, especially when first exposed, tending to a browner shade than the dark gray of the overlying sediments. Third, every one of the many and varied stone wall segments, postholes, stone circles, platforms, and other installations such as hearths and charcoal stains were grounded firmly on the Phase I surface. None at all occurred in the overlying occupation deposits. Fourth (and likewise) all examples of in situ artefact clusters (such as clusters 1–17, see below) were grounded on the Phase I floors. Fifth, artefacts surfaces were consistently bedded horizontally over the Phase I

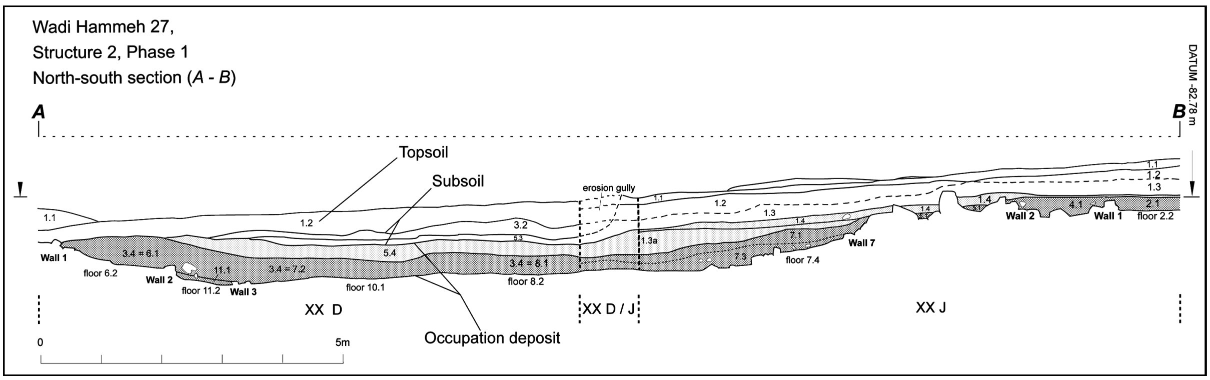


Fig. 3. Wadi Hammeh 27, Section A–B through Phase 1 of Structure 2 (refer to Fig. 2).

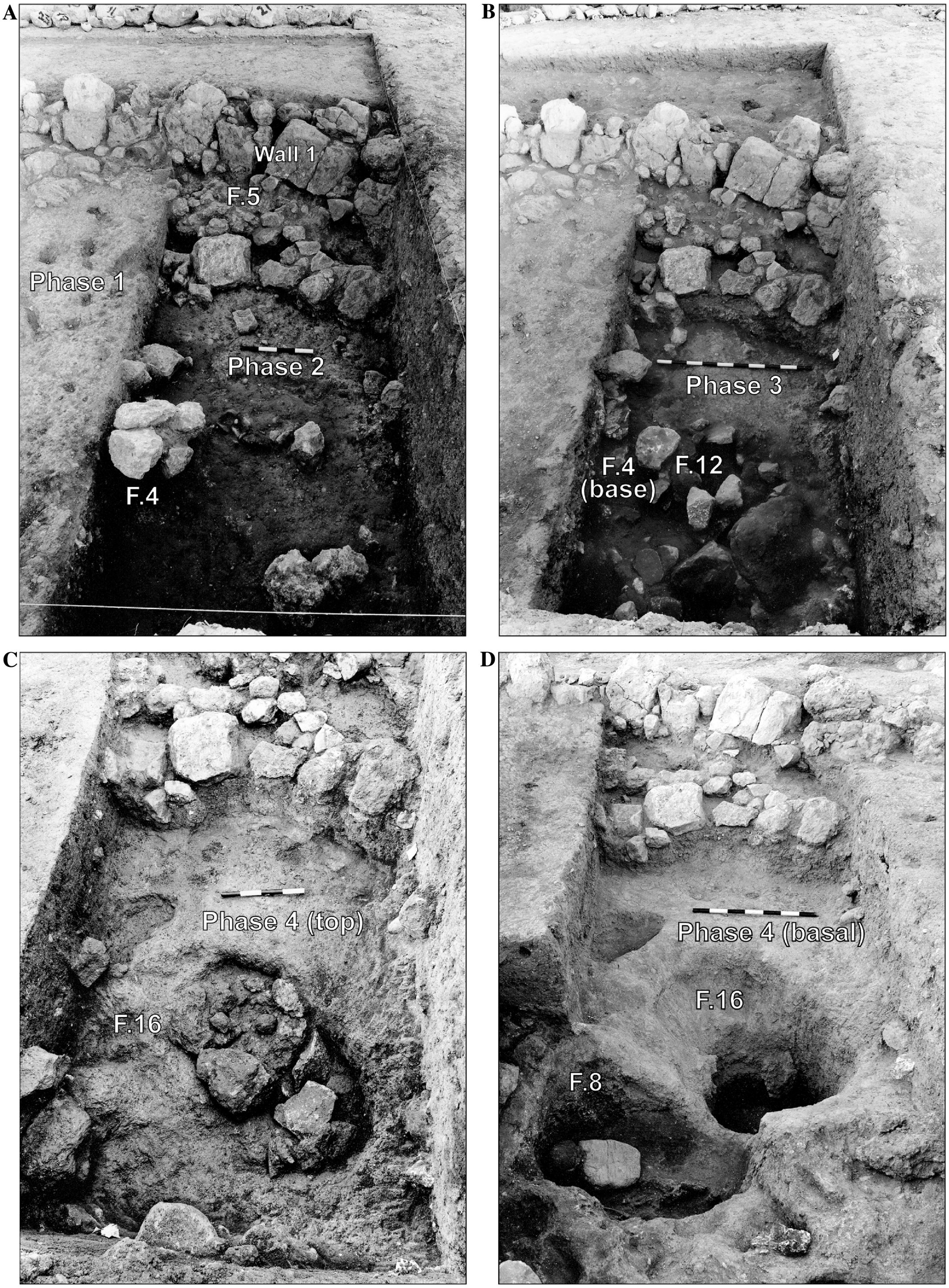


Fig. 4. Wadi Hammeh 27, Views of Phases 1–4 in the Plot XX F sondage (A) Phases 1 and 2, (B) Phase 3, (C) Phase 4 (top), and (D) Phase 4 (basal).

floors, as distinct from the assorted orientations of artefacts in overlying matrix. Sixth, artefacts were much less diverse in type in the deposits above the floors, being dominated by small flaked stone tools and some bone fragments. Finally, the frequencies of all artefact categories increased dramatically on or just above floor level. For example, a major decrease in artefact concentration occurs up through the profile in Structure 2, from Loci 8.1 to 5.4 (Fig. 3). Locus 5.4 is essentially the same dark clay as Locus 8.1, but lacks the high concentration of lithics and bone fragments. A similar series of stratigraphic successions are observable throughout the site, and these criteria applied also to each of the underlying floors of Phases 2, 3, and 4. The dark, humic clay occupation deposit was either completely curtailed or very thin on the exterior surfaces of Structures 1 and 2. Instead, the floors in these areas lay beneath a (10–20 cm) truncated topsoil cover. They still contained numerous Natufian artefacts and debris which were, however, much sparser than within interior deposits.

As a check on our floor-finding facility, we are confident that we did locate the next occupation surface above Phase I, named 'Phase 0,' which is located at the top of Locus 1.2 and its equivalent contexts, set below the modern ground line in the sediments dating to ca. 11,000 BP (Fig. 3). This layer features a small number of isolated installations of uncertain date, but which may be Late Natufian (Webb and Edwards, 2002).

Methods for the analysis of the artefact and refuse distributions

Excavations at Wadi Hammeh 27 were undertaken under the aegis of the University of Sydney Pella Project (McNicoll, 1992), and its procedures and nomenclature were adopted. The Wadi al-Hammeh excavation area was designated as 'Area XX,' as the Roman numeral 'XX' is prefixed to each of the site's excavation squares or 'Plots.' Seven rectangular plots were excavated (Plots XX D, XX E, XX F, XX G, XX H, XX J, and XX K) along with their intervening baulks (Fig. 2). These excavations employed the Pella project's 'locus–level' method (McNicoll, 1992, pp. xiii–xvii). In this system, an area horizontally bounded by constructed features such as walls, pits, roads or natural discontinuities such as erosion gullies is termed a 'locus.' Each stratified deposit within such a locus is termed a 'level.'

After the initial excavation of Plots XX D and XX F, the locus–level system was augmented with a meter-grid. Therefore, these two plots do not have data collected according to the grid system, although the structural features encountered (principally walls), sufficed to permit the clear distinction between interior and exterior material, and indeed both plots were divided into many natural stratigraphic deposits (or loci and levels). For XX D and XX F, a post hoc grid was placed over the excavated areas for this analysis, and total numbers of artefacts in each locus evenly divided amongst the meter grid squares. *ArcView GlS Version 3.0a* was then used to construct gray-scale density plots (numbers per cubic meter) for the various data categories (Figs. 5–15), and a new grid placed over the entire site for this analysis (A/Q-1/31). The density data used in this analysis were limited, for interior layers, to the sealed deposits defined as the 'Occupation deposit,' consisting of the artefactually rich, dark silty clays directly overlying the Phase 1 floors (Fig. 3). The exceptions were the exterior deposits where a single thin layer overlay the Phase 1 floors. Otherwise, items from 'Topsoil' and 'Subsoil' were not used in the analysis. All artefacts and ecofacts were retrieved by dry and wet sieving through 5 mm mesh. All of the sieved artefacts were included in this analysis, together with all other artefacts that were individually collected due to their large size or fragility. In parallel, small amounts of matrix were passed through a half-millimeter fine mesh in a flotation tank to recover archaeobotanical specimens (Colledge, 1994).

Artefact distributions in this analysis are presented as both volumetric densities (artefacts per cubic meter) in Figs. 6, 7, and 15; and as areal densities (artefacts per square meter) in Figs. 5,8–14, and,17, 18. One mode of presentation is not automatically superior to the other, and each has its place. Areal densities display artefact frequencies in square meters, but cannot take into account the variable thicknesses of deposits within the squares, and so in this regard they give misleading impressions of relative density. Volumetric densities are also more useful for comparisons with other sites and contexts. Therefore, we have presented volumetric densities for Total artefacts, Flint (flaked stone) artefacts, and Faunal remains (Figs. 6, 7, and 15).

On the other hand, areal densities give more realistic impressions of the actual quantities of material present. For example, Square I9 within Structure 1 (Fig. 7) has a characteristically high number of flint (flaked stone) artefacts for an interior context, with 3348 artefacts contained in $0.35\,m^3$, yielding a volumetric density of $9569/m^3$. The exterior square F2 has many less flint artefacts (911), which are, however contained in only 2 cm (0.02 m) of deposit, leading to the huge volumetric density of $45{,}550/m^3$. Exterior contexts to the north and west of Structure lie near to the surface where sediments have been partially stripped and winnowed. This state of affairs concentrated artefacts near the surface and exacerbated the volumetric densities of some squares. In this sense, the areal density displayed in Fig. 8 provides a more realistic sense of the amounts of flint artefacts in the site. In the case of artefact classes with low frequencies, such as Human bone fragments (Fig. 18) it seemed to us to be more comprehensible to present the actual numbers (as areal densities), rather than volumetric densities. As a case in point, Square K20 contains a single human bone fragment within $0.20\,m^3$ of sediment. It seems to us to be better to simply state this, than to provide a volumetric density of '5 Human bone fragments/m^3.'

Besides assessing the numbers of objects, we also briefly monitor the weights of some lithic samples as a

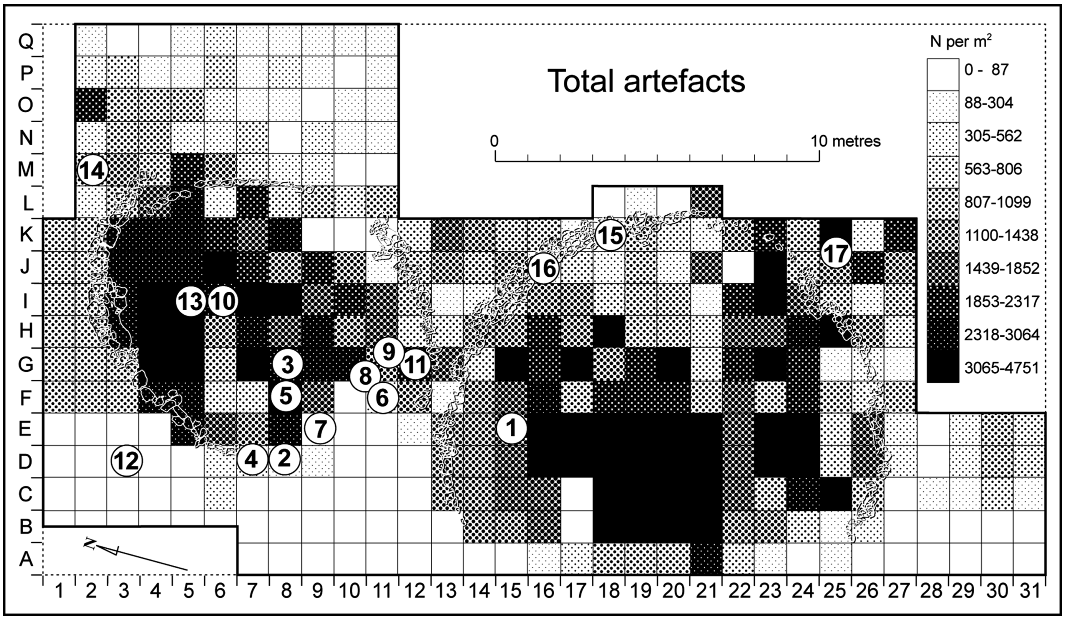


Fig. 5. Wadi Hammeh 27, Phase 1. Areal distribution of total artefacts (the combined total of all categories used in this analysis). Numbered white discs mark the positions of Clusters 1–17 (for descriptions of these, see Table 2).

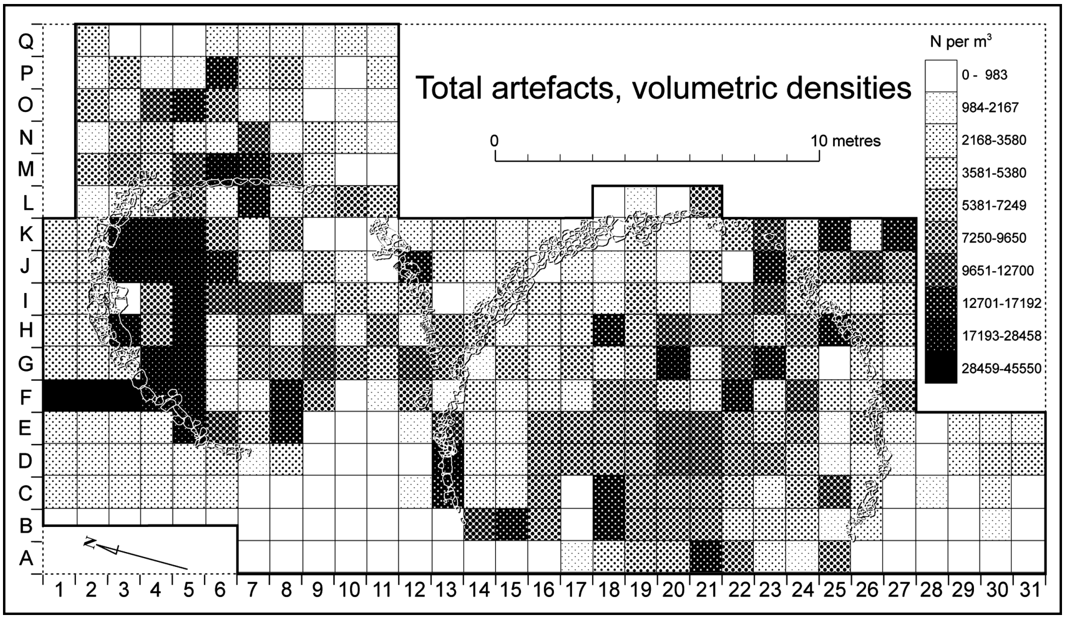


Fig. 6. Wadi Hammeh 27, Phase 1. Volumetric distribution of total artefacts.

guide to establishing their sizes; since it has been observed that in hunter-gatherer sites where mobility is practiced but refuse disposal is considered a relatively unimportant activity (cf. O'Connell, 1987) large, cumbersome items are often cleared away from communal living areas or thoroughfares. The analysis of density data are also interpreted here with recourse to more qualitative observations and interpretations of the Phase I features, such as the nature of its artefact clusters, and their spatial relationship to site walls and other built features.

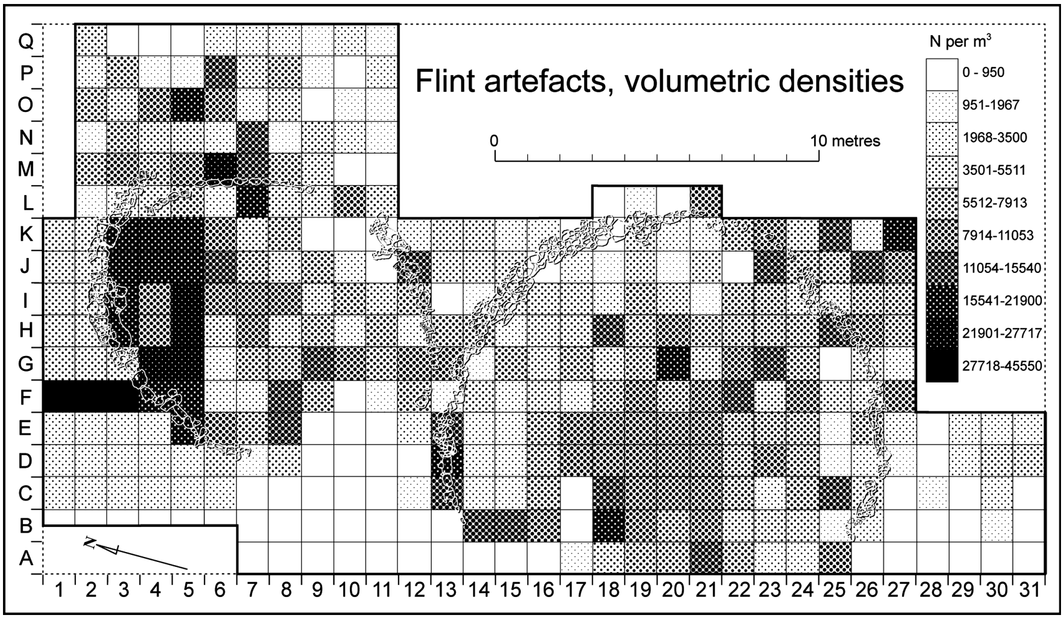


Fig. 7. Wadi Hammeh 27, Phase 1. Volumetric distribution of flaked stone (flint) artefacts.

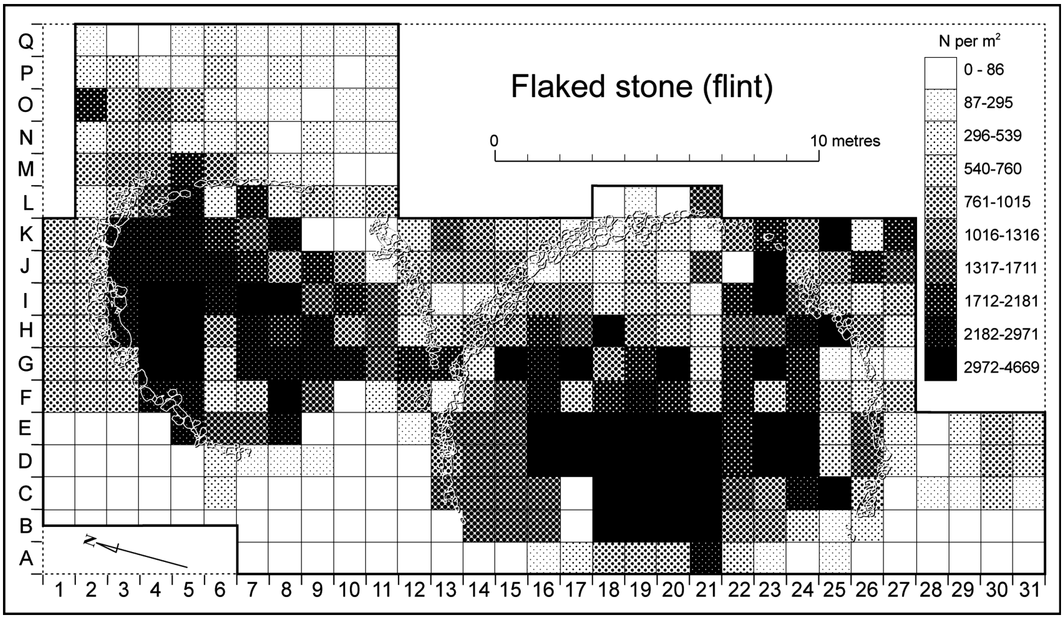


Fig. 8. Wadi Hammeh 27, Phase 1. Areal distribution of flaked stone (flint) artefacts.

The contemporaneity of the Phase 1 floors and the materials deposited on them: the possibility of vertical movement of materials

Our behavioral interpretation of artefact patterns relies upon the demonstration that discards were deposited on the Phase I floors during the period of use of Structures 1 and 2, rather than being tossed in later as dumped rubbish. The majority of discards remained on or near the floor surfaces, although significant proportions were moved up vertically, and a small proportion was displaced horizontally, by agents of post-occupational disturbance. We believe that the Phase 1 strata and their contents are essentially in

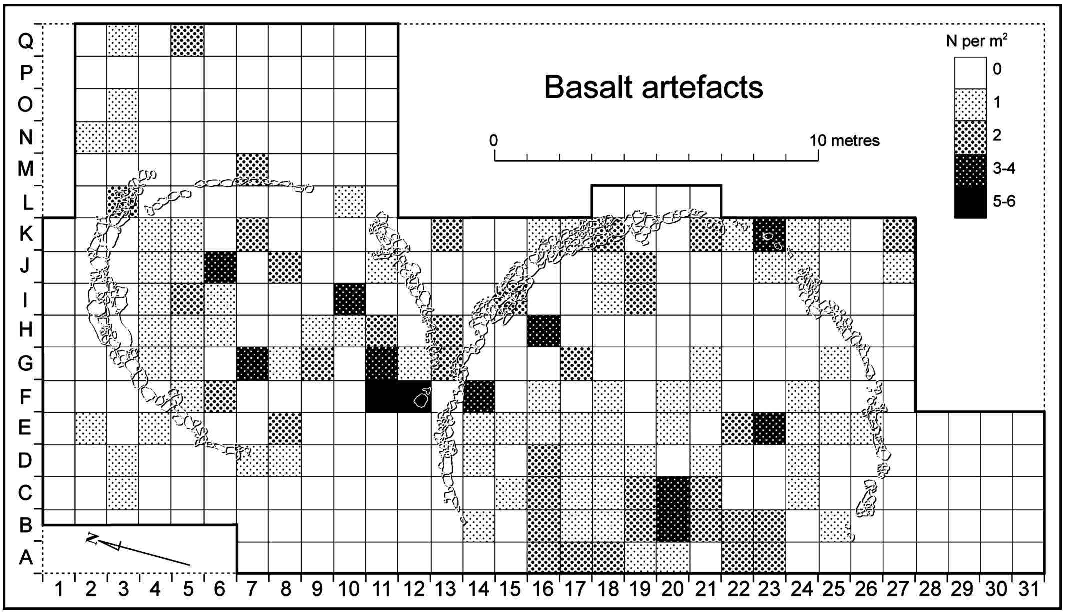


Fig. 9. Wadi Hammeh 27, Phase 1. Areal distribution of basalt artefacts.

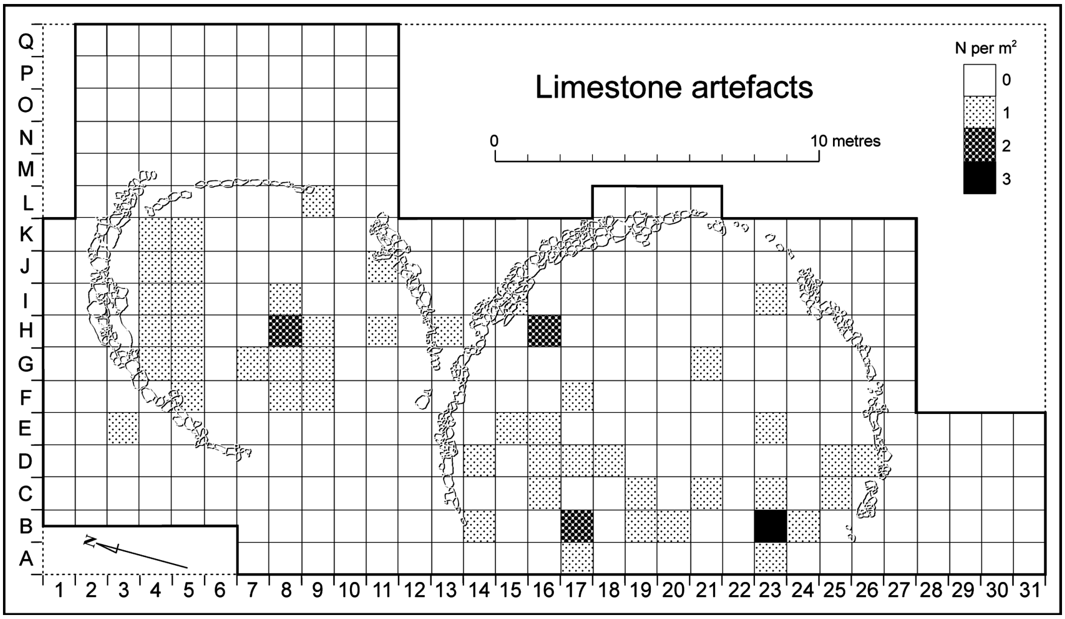


Fig. 10. Wadi Hammeh 27, Phase 1. Areal distribution of limestone artefacts.

situ, though there has been limited vertical displacement of cultural materials both upwards and downwards. Significant evidence for down-slope wasting of materials or horizontal post-depositional movement of materials is lacking.

Three major agents of post-depositional disturbance can be identified at Wadi Hammeh 27: pedoturbation, floralturbation, and faunalturbation (Wood and Johnson, 1978). The first process of pedoturbation stems from the annual alternation of wet winters and dry summers that characterize the southern Levant, and the consequent cycles of wetting and drying of the earth. These seasonal fluctuations cause cracking of Wadi Hammeh 27's clayey deposits during the long dry

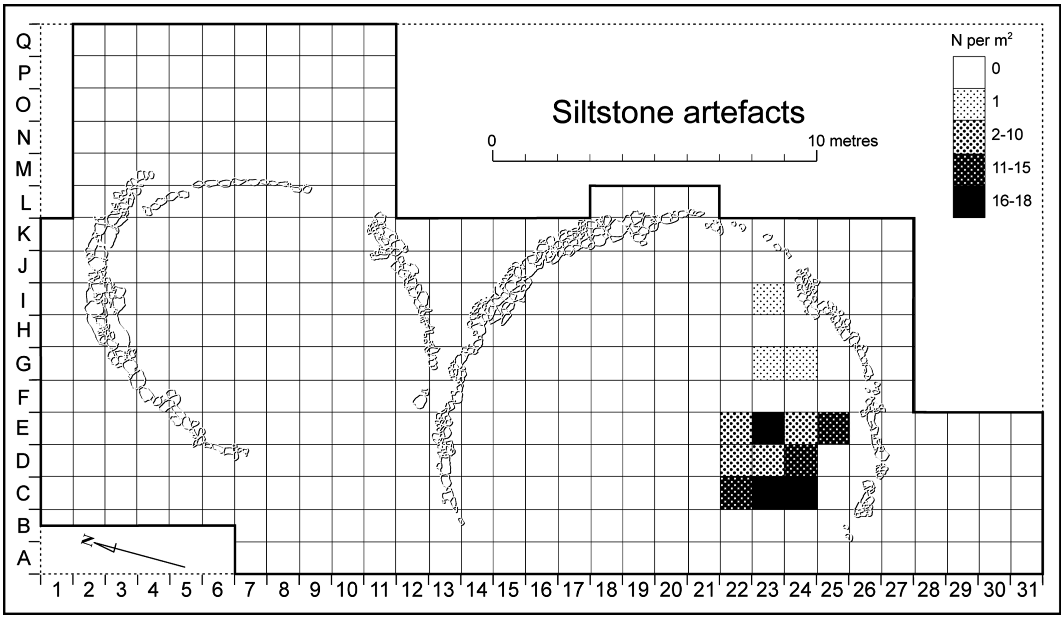


Fig. 11. Wadi Hammeh 27, Phase 1. Areal distribution of siltstone artefacts.

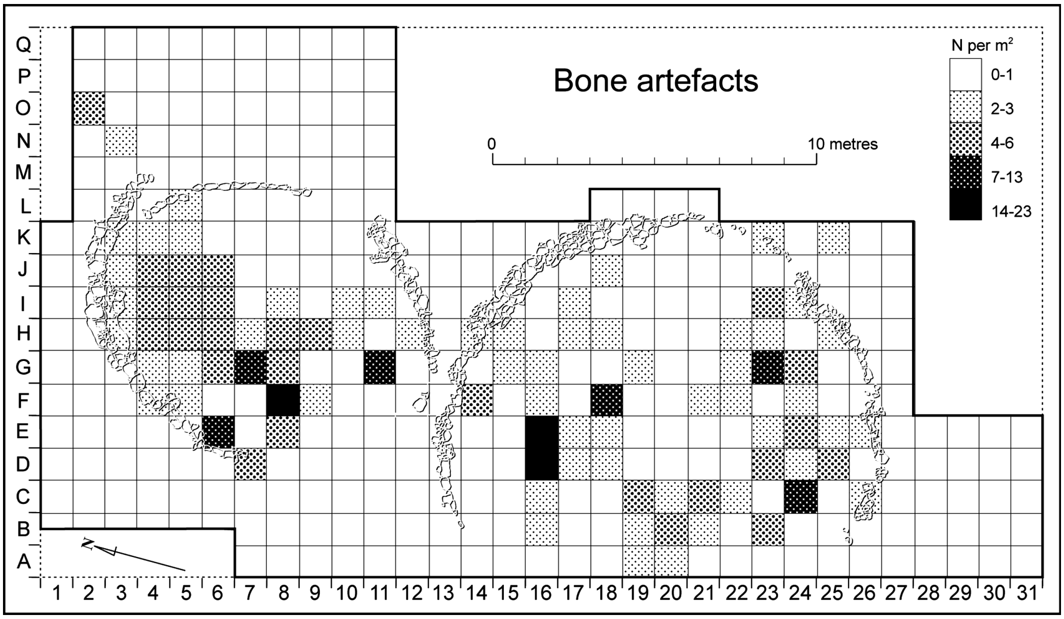


Fig. 12. Wadi Hammeh 27, Phase 1. Areal distribution of bone artefacts

season, and create conduits for the downward passage of archaeological material.

Floralturbation is evident where the bulbs of mature plants (especially *Asphodelus* sp.) have created a series of large irregular hollows in the floors, which may have dislodged cultural materials round in their immediate vicinity. However this damage did not seem very widespread, being evident in only small areas near the western cliff line (Fig. 2) where plants had colonized the site's eroded margins.

Faunalturbation has acted as a major agent of disturbance. The extensive shaft-and-tunnel systems which infiltrated the Phase I Occupation deposits and reached its floor surfaces (dark shading in Fig. 2) are not clearly

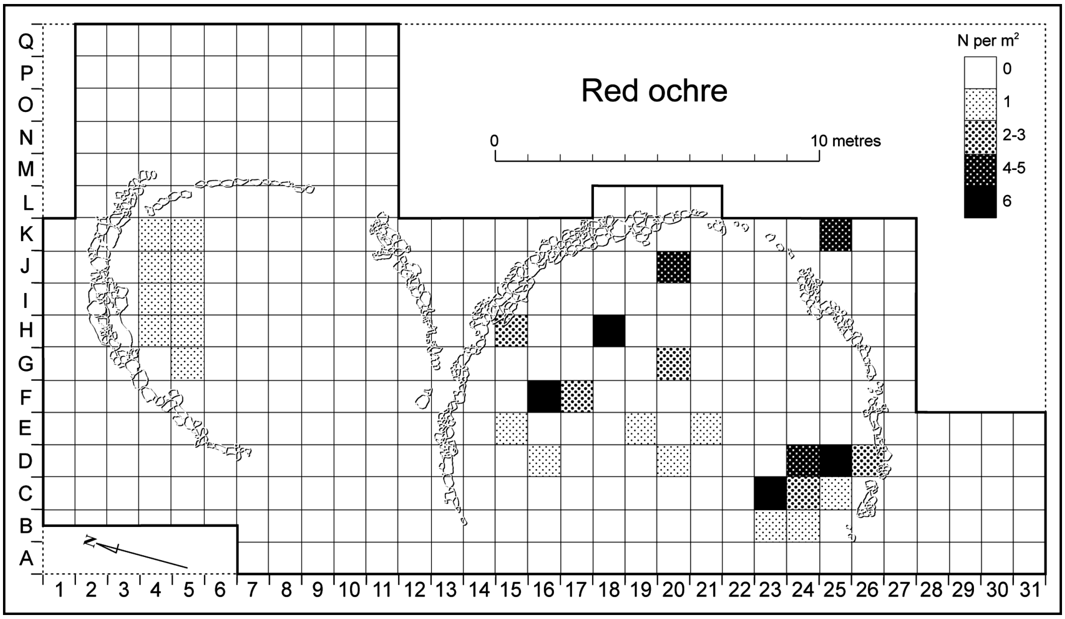


Fig. 13. Wadi Hammeh 27, Phase 1. Areal distribution of Red ochre fragments.

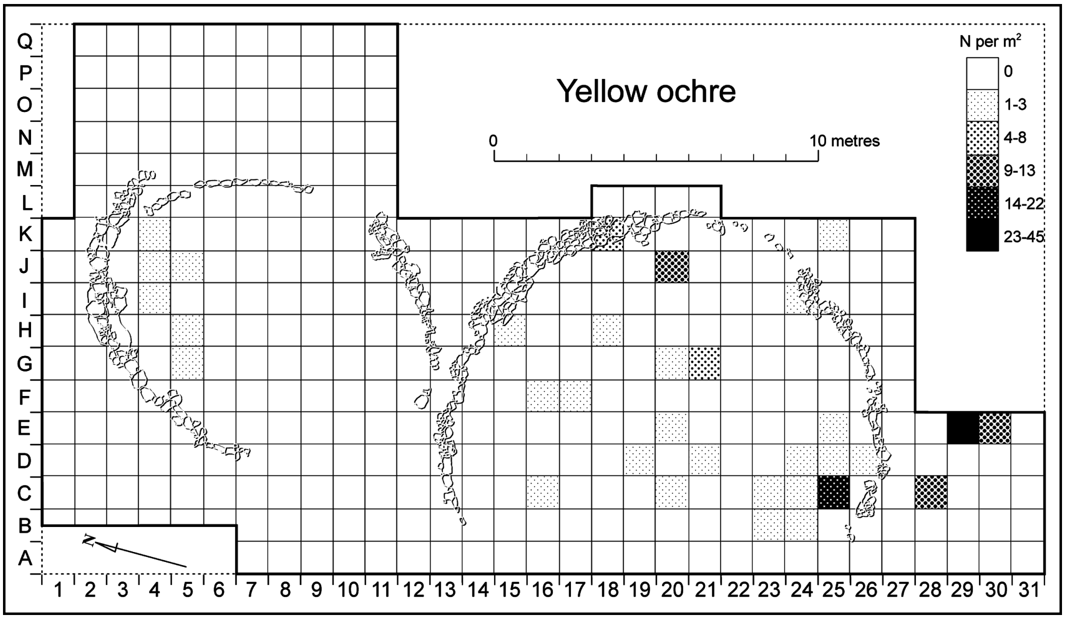


Fig. 14. Wadi Hammeh 27, Phase 1. Areal distribution of Yellow ochre fragments.

attributable to species-level, but *Microtus irani* (the Levant vole, cf. *Microtus guentheri*, Tchernov, 1968) and *Spalax ehrenbergi* (the Palestine Mole-Rat) are the most likely culprits. Both animals habitually construct complex tunnel systems. The latter species at least, which favors the kind of xeric, non-agricultural batha environment (Nevo et al., 1982, p. 1285) that characterizes the region, is still active in Wadi al-Hammeh (Edwards, 1987). The burrowing endeavors of rodents have transformed the site into a veritable 'Swiss cheese,' throwing up quantities of burrowed earth and archaeological material into higher strata.

Since pottery sherds and other materials lying on the surface of the site are attributable to several pe-

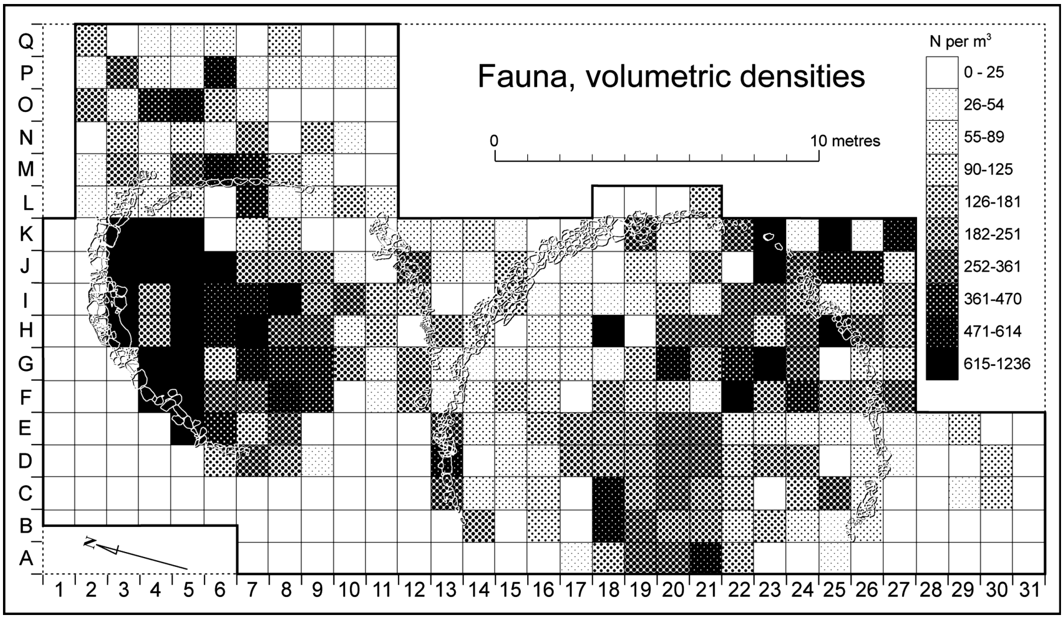


Fig. 15. Wadi Hammeh 27, Phase 1. Volumetric distribution of Faunal remains.

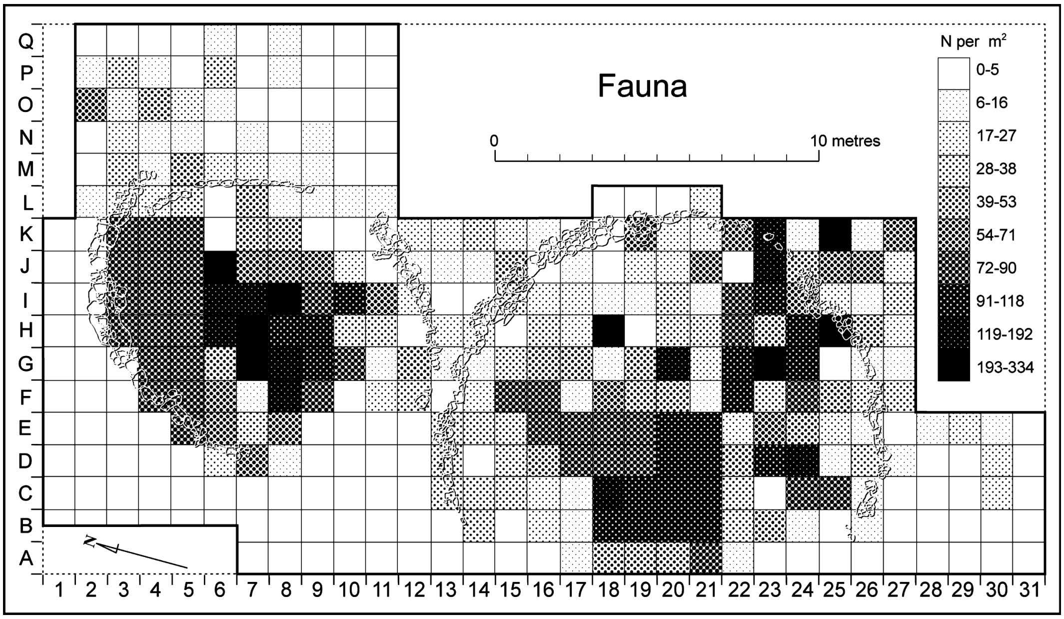


Fig. 16. Wadi Hammeh 27, Phase 1. Areal distribution of Faunal remains.

riods from the Chalcolithic (6500–5300 years BP) through the Umayyad period (i.e., early Arab, ca. 660–750 AD), onto the 20th century, the proportion of these later artefacts displaced downwards through the site's layers could be estimated. Fig. 22 shows the vertical distribution of both Natufian flaked stone (inclusive of tools, debitage, and debris) and later ceramics.

The degree of downward contamination by potsherds is consistent but slight. The 'modern' artefacts consist mainly of potsherds of Byzantine/Umayyad Coarse Terracotta, with the odd fragment of metal and glass.

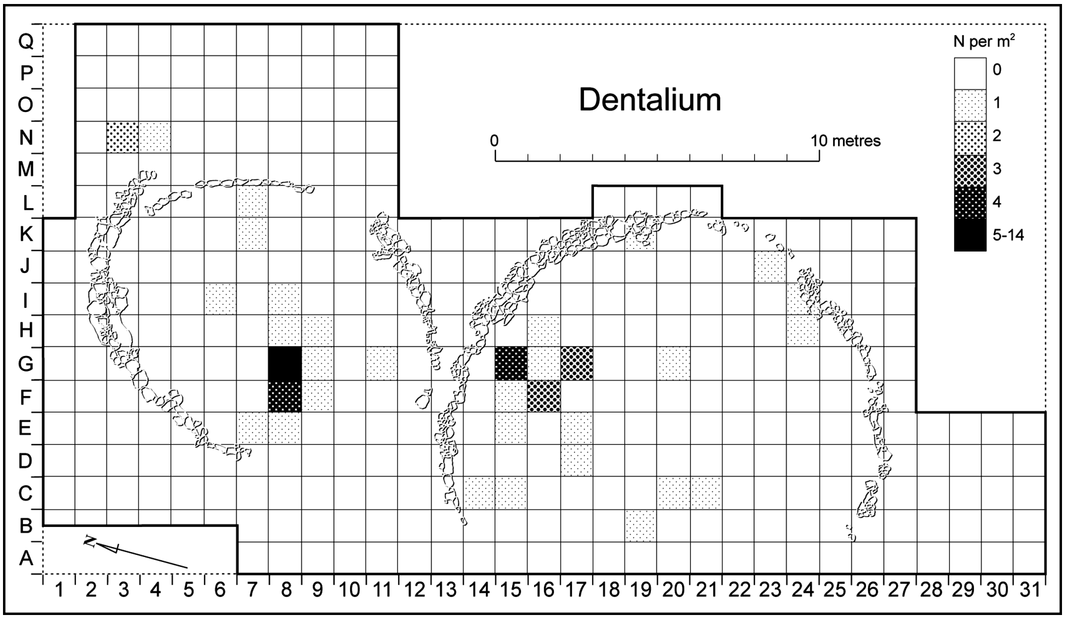


Fig. 17. Wadi Hammeh 27, Phase 1. Areal distribution of Dentalium shells.

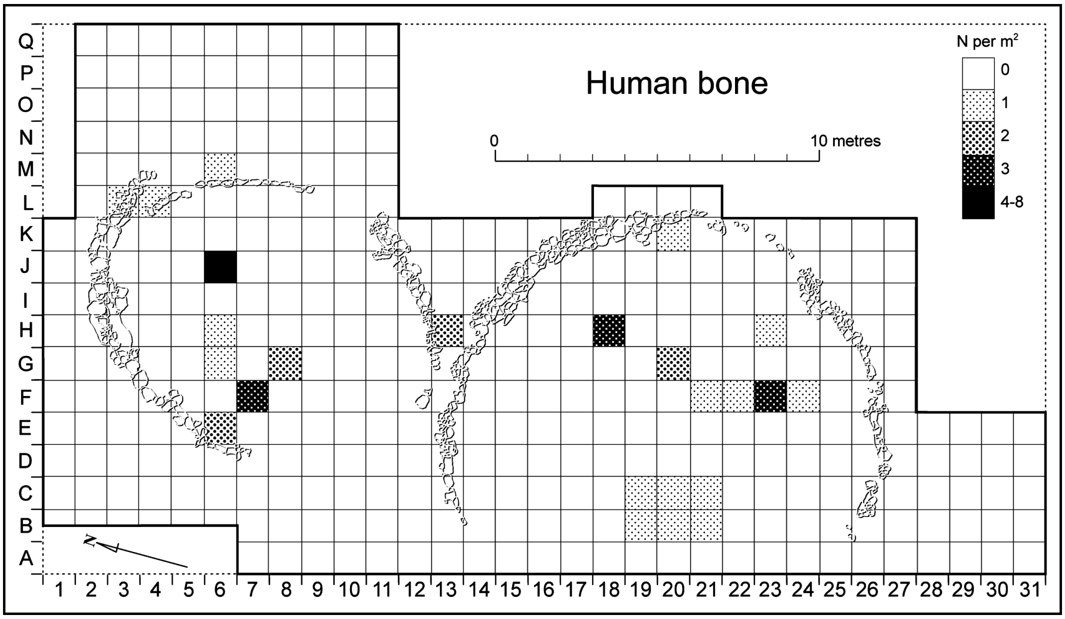


Fig. 18. Wadi Hammeh 27, Phase 1. Areal distribution of Human bone fragments.

Four percent of modern artefacts penetrated down to the Occupation deposit, 12% as far as Subsoil, and 84% remained in Topsoil. Only 1 potsherd penetrated through to the lower phases (indeed to Phase 4), resulting in a contamination rate of 0.3% (1/335) for later objects moving between phases. In three plots (XX E, XX F, and XX J) no later contamination reached the Occupation deposit. In a further three (XX H, XX K, and XX G) the percentages are 4, 4, and 8 respectively. Only in Plot XX D does this rise substantially to 18%. Conversely, all plots (except XX H with 69% where most of the sherds have not penetrated to the Occupation deposit but are lodged in the underlying Subsoil) retain 82–97% of sherds in Topsoil. The vertical distribution of later potsherds, and a few glass and metal fragments, demonstrate how a small amount of later material has filtered downwards from discard locations on Topsoil, with decreasing frequency through successive layers. We propose that the annual creation of multiple soil fissures has provided the principal means for the downward passage of these small objects. Judging by the minor vertical movement of later cultural materials, downward movement of Natufian lithics cannot have been a significant post-depositional modifier of the site either.

The presence of rodent activity also raises the issue of the converse process, namely the upward relocation of Natufian cultural materials. Since we have no evidence of any floors of living surfaces above the Phase I floors, we consider that the cultural materials in the Subsoil and Topsoil layers were most likely derived from their original concentrations on or just above the Phase 1 floors. The proportions of lithics in the basal Occupation deposits of Phase 1 range from 69 (Plot XX K) to 86% (XX D). For the two northernmost plots XX G and XX F, this figure falls to 55 and 37%. However, in this northern area of the site, the upper layers have been stripped away by erosion, whereas the Occupation deposits in the southerly plots such as XX D, XX H, and XX K are overlain by a full sequence of Subsoil and Topsoil deposits (Fig. 22).

Lithics totals for the Subsoil deposits (10%) are lower than for Topsoil (23%) because 'Subsoil' is comprised of lenses of relatively small volume, whereas 67% of lithics remain in their conjectured layer of origin in the Occupation deposit. Given the conspicuous network of rodent tunnels that penetrated the Occupation deposit, we suggest that a considerable amount of the 33% of material occurring above the Occupation deposit has been churned up by burrowing rodents. Most material, however, remains in the original stratum of deposition. Where the rodents have not hit, the numerous clusters and functionally related arrangements of artefacts and features remain intact.

Since studies of rodent disturbance of Levantine sites are in their infancy, we turn to the more highly developed North American academic tradition in support of our conclusions. These studies (e.g., Erlandson, 1984) have focused on the burrowing Pocket Gopher (*Thomomys bottae*), whereas our suspects are *Microtus irani* and *Spalax ehrenbergi*. Nevertheless, the Pocket Gopher shares fairly close relationships with its Levantine counterparts (Nowak, 1999). It is similar enough in size, and constructs burrow systems of similar size, depth and structure, as to make it a reasonable proxy for them.

The Pocket Gopher develops elaborate systems of burrows which include shafts, tunnels, and chambers for nesting and food storage (Bocek, 1986). Its usual zone of operations (the 'rodent zone') lies between the surface and a depth of 30 cm, and its tunnels may extend laterally for tens or hundreds of meters (Bocek, 1986). Average tunnel diameter is 6.3 cm (Bocek, 1992), which provides an upper limit to the sizes of objects which might be transported through the tunnels, however Bocek (1992) observed that 3.5 cm was the maximum dimension for transported items in Pocket Gopher tunnels.

Both *Microtus* and *Spalax ehrenbergi* are similar in size to the Pocket Gopher (Nowak, 1999), and also create similar burrow systems to the North American rodent. *Microtus* constructs intricate systems of tunnels, burrows and nests, usually situated in depth between 15 and 45 cm from the surface. Its tunnels are usually 5 cm in diameter (Nowak, 1999, p. 1472). *Spalax ehrenbergi* creates a similarly elaborate complex of tunnels, nests, storage rooms and defecation chambers. Most tunnels lie 15–25 cm beneath the surface, with living and storage rooms extending 20–50 cm deep (Nowak, 1999, p. 1427).

These are similar to the sediment depths that cover the Wadi Hammeh 27 Phase I floors, and, judging by North American parallels, the amounts of Natufian lithics and other materials that are found in Subsoil and Topsoil could be accounted for as material displaced upwards by burrowing rodents. Erlandson (1984, p. 789) found that 27% of molluscan material in the Californian site of CA-SBa-1582 had been redeposited. At the Jasper Ridge site, California, Bocek (1992, p. 264) found that the equivalent of 13% of lithic material originally found in Unit 18 had been redeposited by the Pocket Gopher over a period of seven years, and that most of the redeposited material was relocated into the upper ten centimeters of the soil profile. At Wadi Hammeh 27, the percentages of lithics situated above the Occupation Deposit are 14% (Plot XX D), 20% (Plot XX H), 24% (Plot XX J), and 31% (Plot XX K), and it seems to us most likely that these quantities are attributable to the activities of burrowing rodents evacuating their tunnels of sediment towards the surface.

The contemporaneity of the Phase 1 floors and the materials deposited on them: the possibility of horizontal movement of materials

The dark gray clays that have contributed most significantly to the Wadi Hammeh 27 sediments were ultimately derived from groundwater springheads situated 100 m to 200 m upstream of the site. There is, however, no evidence that archaeological materials from the site have been shifted downstream. This is evident from the fine structure of the sediments themselves, reflecting low-velocity conditions of sedimentation (Macumber, 1992, p. 213). There is no trace of general downstream mass wasting, or size sorting of materials. On the contrary, the materials are heavily clustered within Structures 1 and 2, except for the two clearly defined patches of material in Plot XX J (upstream of Structure 1) and in Plot XX G (east of Structure 2) and are not displaced along their downstream margins. Within the two structures, artefact patterns are also coherently patterned as a result of in situ behavioral activity. The eastern half of Structure 2 has a radial pattern of artefact density with most objects, both individual and cached, clustered near Wall 1 to the east. In Structure 1, the majority of Clusters and activity area remnants are clustered toward the west, near to the opening of the structure and the available light.

The conjoining bone tools found lying in situ, include gazelle phalanges and gazelle podial beads in preparation, reflect the many steps involved in the manufacture of these ornaments. Numerous clusters of articulated artefacts are interleaved with a mosaic of other artefacts and refuse, horizontally bedded in dense fashion across the interior floors, and associated with a variety of hearths and other and constructed features. Numbers of complete basalt and limestone artefacts were carefully stacked in both structures, and broken basalt artefacts have been recycled in the construction of the stone walls, rather than thrown in to the structures. The presence of artefacts and refuse from a full range of activities and stages of manufacture rules out an interpretation of the assemblage as secondary refuse, which is characterized by broken, exhausted or worn artefacts. For the flaked stone assemblage, this point can be made with additional force, since cores, core-reduction products, and the myriad small shatter products from in situ flaking commingle on the floor surfaces.

The lateral movement of cultural materials by rodents is usually minor, relative to the quantities vertically transported (Bocek, 1986, p. 590), but remains an issue requiring attention in this context. In the case of the Pocket Gopher, lateral transport of materials was limited to 3.5 cm or less in size (Bocek, 1992). Our excavations in Phase 1 paralleled this experience. Originally, we had intended to excavate and isolate the contents of all encountered rodent burrows at Wad Hammeh 27, but we rapidly ran into the logistical difficulties also encountered by Erlandson (1984, p. 785), who relates, in regards to the Pocket Gopher that:

> Due to the volume and complexity of sediment displaced through faunalturbation, it was not possible to separate in situ deposits from material in rodent krotovina during excavation.

We also found the spooning-out of loose sediment to be impracticable, since the burrows usually extended out of hand's reach, turned corners, and in some cases even turned upwards. Initially two burrows were excavated, (Loci 3.5 and 3.11 in Plot XX D), the contents of which parallel Bocek's (1992) conclusions about the small and limited amount of materials transported laterally. The first burrow context returned 35 small lithic fragments comprising 25 small chips, 6 broken flakes and bladelets, 2 complete flakes, and 2 complete bladelets. The second one yielded 27 small lithic fragments comprising 15 small chips, 11 broken flakes, and 1 broken lunate; in addition to two small mollusk shells. The amounts and types of materials and the distances they traveled laterally thus appear to be limited. (Subsequently, these burrow assemblage totals were reassigned to their appropriate deposit matrices, and in this analysis they are included in the Occupation deposit totals for their respective grid squares). These various lines of evidence provide supportive evidence that the Phase 1 deposits do not represent secondary discard deposited within the structures from elsewhere, nor include significant percentages of horizontally displaced materials.

The time span represented by the Wadi Hammeh Phase I deposits

It is important to consider the appropriate temporal frame of reference for Wadi Hammeh 27. Most models of refuse and abandonment have been derived from ethnographic sites associated with short, inter-annual timescales. That is, the patterns correspond to occupancies of seasonal, monthly, weekly, or even shorter durations. However, recent awareness about the complexity of temporal interpretation of archaeological deposits casts doubt on the relevance of the 'very short term' to many archaeological deposits (Bailey, 1981, 1987; Fletcher, 1992; Rensink, 1995). At the heart of the issue is the recognition that our radiometric methods come with inbuilt limits of precision, beyond which no finer temporal resolution is possible (Murray, 1999; Stern, 1993).

The Phase I dates are indistinguishable statistically, but neither they nor even the most optimally precise dates could distinguish between occupancies of inter-annual, perennial or decadal extents. While the temporal extent of Phase I is indeterminate, our suspicion is that it represents repeated occupancies accumulated over years, at the least. The generalized nature of the activities has resulted in a "coarse-grained" assemblage (Binford, 1978) of accumulated archaeological remains from superimposed activity events.

We prefer to envision the Phase I patterns as accumulations of successive events, and if, these patterns have been preserved coherently, they have been so because they reflect a persistency of human actions in residential space over the long-term. These behaviors include a general indifference to relocating refuse to exterior areas, the positioning of hearths against the inside of walls, the caching of equipment against interior walls, the removal of some heavier items away from the thoroughfares of domestic space, and the execution of craft activities near to openings and available light.

Wadi Hammeh 27 artefact distributions

Prodigious numbers and many types of artefact and refuse classes were discarded at Wadi Hammeh 27 (Hardy-Smith, 1996). Large masses of lithic debitage, bone food scraps, abandoned activity areas, caches of neatly stacked bone and stone tools, elaborate art pieces, and burnt human skull fragments all coalesced on its 12,000 year-old occupation surfaces. The spatial data enshrine a wealth of important information, even without considering the locations of the various lithic debitage, debris and retouched tool classes such as burins, scrapers, and microliths, or the types and varieties of other stone and bone artefacts, or the various faunal species. Undoubtedly more insights would be gained by examination of these individual classes, however limitations of space preclude those inquiries being pursued in this presentation. The following sections describe the disposition of the major analytical categories used in this study: total artefacts, flaked stone (flint) artefacts, groundstone artefacts (including basalt, limestone, and siltstone types), bone artefacts, red ochre fragments, yellow ochre fragments, faunal remains, dentalium shells, and human bone.

Total artefacts

Over 439,000 artefacts have been recovered from the Phase 1 deposits alone (Table 1) and 82% of them lie within the confines of Structures 1 and 2 on interior surfaces. This pattern is displayed best by the plot for areal densities (Fig. 5), which illustrates interior densities reaching 4751 artefacts/m^2. Table 1 details the interior and exterior artifact densities for each of the excavated Plots. Vertically, 87% of artefacts were recovered from the 30-cm thick, dark gray clay deposits (or 'Occupation deposit') that overlie the floors.

Volumetric densities are high, especially west of Structure 1 (e.g., Square I5) where values of 28,458/m^3 were reached. The highest volumetric densities are attained in exterior contexts (45,550/m^3 in Square F1) but these were exacerbated by relatively few items contained within very thin deposits. The density plot for Total artefacts (Figs. 5 and 6) is heavily influenced by the distribution of Flint artefacts (Fig. 8), since the latter category comprises nearly 97% of total artefacts. For this reason, overall density patterns are discussed in the next section (on flint).

Flaked stone (flint) artefacts

A total of 423,858 flaked stone artefacts were recovered from the Phase 1 Occupation deposits (Fig. 8); 82% of them from inside Structures 1 and 2. A higher percentage of the interior totals (64%) were contained within Structure 2 as opposed to Structure 1 due to the former's larger interior area (Table 1).

Interior volumetric densities reach 45,550/m^3 (Fig. 7), the same value as for Total artefacts, and areal densities attain 4669/m^2 (Fig. 8). The highest numbers of flints occur in the northern part of Structure 1 and the western sector of Structure 2. In the first case, lithics cluster heavily around stone Features 6, 7, 8, and 9 and against Wall 1 (Fig. 2). A tongue of dense lithics also extends

Table 1
Wadi Hammeh 27, Phase 1. Artefact numbers and frequencies from interior and exterior deposits

Artefact/ecofact category	Total artefacts	Interior artefacts		Exterior artefacts		Interior artefacts, Structure 1		Interior artefacts, Structure 2		Structure 1, average density items/m^2	Structure 2, average density items/m^2
	N	*N*	%	*N*	%	*N*	%	*N*	%		
Lithics	423,858	347,001	82	76,857	18	125,256	36	221,745	64	1899	1911
Fauna	13,889	11,883	86	2006	14	5006	42	6877	58	76	59
Basalt	191	165	86	26	14	66	40	99	60	1	0.9
Limestone	59	58	98	1	2	24	41	34	59	0.4	0.3
Siltstone	133	133	100	0	0	0	0	133	100	—	12
Bone artefacts	400	379	95	21	5	170	45	209	55	3	2
Red ochre	237	212	90	25	10	53	25	159	75	0.8	1.4
Yellow ochre	150	70	47	80	53	6	9	64	91	0.1	0.8
Dentalium	74	69	93	5	7	37	54	32	46	0.6	0.3
Human bone	16	15	94	1	6	5	34	10	66	0.08	0.08
Semi-precious Stones	19	19	100	0	0	8	42	11	58	0.1	0.1
Total	439,026	360,004	82	79,022	18	130,631	36	229,373	64	1979	1977

through the center of Structure 1, immediately to the south of Features 20 and 21 (G/H 7), and around Feature 15. Flaked stone density in Structure 2 is highest in its western sector, in the area enclosed by Wall 3 to the north and Feature 18 to the south.

Flint densities are markedly lower over the northern and eastern areas external to Structure 1. They are highest in Feature 7, Plot XX G (O/P-2/4), a roughly rectangular depression with an area of approximately $4.5\,m^2$, and particularly in Square O2. Lithic weights are also comparatively high in Feature 7. External areas in general, as well as areas immediately inside the walls, show a correspondence between relatively low artefact numbers and relatively high average weights. Average external flint weight lies between 5.1 and 7.4 g, which is substantially higher than within Structures 1 and 2, any indeed higher than anywhere elsewhere on the site. Conversely, low average weights accompany the high lithic densities of the F5-K3/5 region in Structure 1.

Groundstone artefacts

Three hundred and eighty-three basalt, limestone, and siltstone artefacts were recovered from the Phase 1 deposits, with 93% of these retrieved from within Structures 1 and 2. Feature 7 in Plot XX G and the exterior stone circle (F.3) in Plot XX F (Square D2) contain most of the external examples. More detailed consideration of the various pecked and ground stone artefact classes is given below according to raw material class.

Basalt artefacts

This category includes food-processing and percussive tools such as mortars, pestles, querns, and hammerstones, as well as a number of small plates and miniature bowls (Edwards, 1991; Wright, 1991). Eighty-six percent of the basalt artefacts come from interior contexts (Table 1, Fig. 9). Structure 2 has more basalt items (60% of the total) due to its larger area. The regions in Structures 1 and 2 with high concentrations of flaked stone also include the densest occurrences of basalt artefacts, but the basalt distributions are necessarily patchy by contrast, consequent to their low relative numbers, and also because many of them were discretely cached rather than widely scattered. Indeed, the highest concentrations of basalt in Structure 1 are represented by three individual deposits of tools (Clusters 6, 8, and 11; Figs. 5, 19A and B), with a fourth one (Cluster 2) just outside its entrance. Further inside Structure 1, complete basalt artefacts are notably clustered in the vicinity of stone Features 6, 7, 8, 20, and 21. In contrast to the remarkable tableaux of cached items, broken basalt artefacts were often frequently recycled in the construction of the hut walls.

Limestone artefacts

Fewer limestone (59) than basalt artefacts occur. Limestone was the preferred raw material in the manufacture of a series of grooved, whittled, and incised pebbles, figurines, pendants, and fragments. Ninety-eight percent of limestone artefacts come from interior contexts (Table 1, Fig. 10). Structure 2, with its larger interior area, has more of the limestone items (59% of the total). All of the decorated limestone artefacts were found inside the two structures: 85% from Structure 2 and 15% from Structure 1. The western sector of Structure 2 (Plot XX D) is richest in this regard, yielding 44% of the inventory of decorated artefacts.

Siltstone artefacts

This category (Fig. 11) consists largely of fragments which bear incised decorations. All come from Structure 2, with many occurring in Squares C/E-22/25, just to the west of the boulder arrangement (Feature 9). The siltstone cluster may represent the vestiges of a work area associated with the nearby trio of engraved siltstone and limestone slabs (Feature 2) which formed the western terminus of Wall 3 (Edwards, 1991).

Bone artefacts

A total of 400 bone artefacts were recovered from Phase 1 (Fig. 12). Ninety-five percent were recovered from interior deposits, with a few fragmentary points and worked fragments retrieved from the exterior deposits in Plot XX G, once again associated with the depressed Feature 7. Otherwise only one other worked fragment was recovered from the exterior of Structure 1 (in Plot XX J). A comparison of Structures 1 and 2 shows that the average density of worked bone artefacts is similar (2–3 artefacts per m^2, Table 1), but the larger area encompassed by Structure 2 yielded larger quantities of bone artefacts than Structure 1. Sixty-two percent of 76 gazelle podial beads, tubular bone beads, and bone pendants were recovered from the interior deposits of Structure 1, primarily distributed in a broad swathe extending from the north of the structure to a region near its entrance to the west. Thus, the pattern observed for basalt and siltstone is also followed by the distribution of worked bone artefacts. However, most of the bone tool clusters appear to represent the residues of artefact manufacturing areas, discarded in situ, rather than the caching of finished tools for later use, such as we see with the basalt tools. The most informative case in this regard is Cluster 4 (Fig. 5), located just next to the posthole (Feature 13) at the entrance to Structure 1. It comprises a pile of phalanges (used as the raw material for making gazelle podial beads) together with a drilled gazelle podial bead, and a drilled bone pendant. Two meters away, on the interior of the Structure 1 floor was located Cluster 5, which included 7 bone artefacts and 3

Dentalium fragments. Next to Cluster 5 against the stone circle Feature 16 was Cluster 7, which comprised three drilled bone artefacts. In Structure 2, bone tools tend to form a roughly radial distribution, away from the center of the outer dwelling. To a much greater extent than artefacts of limestone or siltstone, bone artefacts extend in numbers along the southern wall of Structure 2.

Red ochre fragments

Two hundred and thirty-seven fragments of red ochre were recovered from the Phase 1 Occupation deposits (Fig. 13), with 90% of these located in interior deposits (in this category is also included a type of pink ferruginous limestone). Red ochre is more common than yellow (see below), and it occurs much more frequently in Structure 2 (75%) than in Structure 1. Relatively heavy but sporadic concentrations of red ochre occur in Structure 2's eastern sector (Squares F16, H18, and J20), with the heaviest amounts occurring south of the Feature 9 boulder cluster (Squares B/D-23/26), virtually coincident with the heavy cluster of siltstone fragments (above).

Yellow ochre fragments

One hundred and fifty fragments of yellow ochre were recovered from the Phase 1 Occupation deposits (Fig. 14). Yellow ochre is even more heavily concentrated away from Structure 1 than is red ochre, with 90% of interior finds found in Structure 2 or to its south. Like Red ochre and Siltstone, it is concentrated strongly in the region south of the boulder cluster (F.9). Overall, only 53% of Yellow ochre comes from interior contexts; its low proportion resulting from a large number of fragments (58) which were found in Squares E 29 and E 30.

Faunal remains

A total of 13,889 faunal fragments were recovered from the Phase 1 deposits, representing a diverse array of taxa including gazelle, pig, equids, sheep/goat, aurochs, red deer, fallow deer, roe deer, wolf, fox, cat, hare, partridge, stork, duck, gull, owl, coot, tortoise, and crab. Eighty-six per cent of bone fragments were recovered from within Structures 1 and 2 (Fig. 16, Table 1). Structure 1 yielded fewer interior examples (42%), however it had a higher average faunal density than Structure 2. Fauna is one of only two refuse categories in this analysis (the other being Dentalium) which is more heavily represented in Structure 1 than in Structure 2 (Table 1). Faunal remains are particularly low in most exterior contexts, leading to very similar patterns for both the volumetric and areal density presentations (Figs. 15 and 16). In addition, significant faunal (as well as flaked stone densities) occur in the Feature 7 depression east of Structure 1, and in the refuse dump (F.9, or Cluster 17) outside the peripheral wall of Structure 2.

The faunal distribution pattern is generally a less intense reflection of the Flaked stone pattern, with a notable difference being that faunal fragments are most heavily concentrated in the center of Structure 1 (Squares J6-F8), rather than to its north, like the Flaked stone refuse. The hearth (F.15) in Structure 1 and Features 11a, 15, and 18 in Structure 2 are also associated with individual squares of high bone fragment density. Faunal fragments represent the remains of animal butchering and meat consumption. Furthermore, bone was also widely used in artefact manufacture, and the contextual association of fauna and bone artefacts is particularly clear in the case of the gazelle phalanges.

Dentalium shells

Dentalium shells may be considered a special case among faunal categories, since they were exotic marine items imported for the purpose of manufacturing ornaments. Seventy-four *Dentalium* shells and fragments were recovered from Phase 1; 93% from interior deposits (Fig. 17). These were distributed fairly evenly with 54% from Structure 1 and 46% from Structure 2, but *Dentalium* is only the second refuse category (after 'Fauna') which is more frequent in Structure 1 than in Structure 2.

Human remains

In addition to two sets of burials found underneath the site, the interior Phase 1 deposits yielded 16 human bone fragments, primarily burnt cranial fragments (Webb and Edwards, 2002). Only one was found from the exterior. The distribution of fragments is broadly confined to two restricted areas in Structure 1 and Structure 2 (Fig. 18) with 34% coming from the former and 66% from the latter. Both structures, however, contain approximately equal densities of them.

Clusters 1–17: evidence for de facto, primary and secondary refuse deposits

Seventeen distinct artefact clusters (Clusters 1–17) were recovered from the Phase 1 Occupation deposits (Fig. 5). Clusters 1–17 represent nucleated artifact concentrations found in such close association that their propinquity and patterned arrangement provide evidence of either a single action or a sequence of actions carried out over the short-term. As a useful heuristic we have divided them into the categories of De facto refuse deposits, Primary refuse deposits, and Secondary refuse deposits (Table 2). A De facto refuse deposit is defined

Table 2
List of Artefact Clusters (1–17) for Wadi Hammeh 27, Phase 1 (for locations, see Fig. 5)

Cluster No.	Provenance	Grid square	Description	Refuse deposit type
1	XX D 11.1	E15	Cluster of two drilled Dentalium beads and two Dentalium fragments	Primary
2	XX E 1.2	D8	Pair of basalt pestles, one with raised relief band	De facto
3	XX E 2.2, Gb-1	G8	Basalt mortar base with (at least 6) Dentalium shells scattered about it	Primary
4	XX E 2.2, Da-1	D7	Pile of gazelle phalanges, together with grilled gazelle podial bead and drilled bone pendant	Primary
5	XX E 2.2, Fb-1	F8	Cluster of 7 bone artefacts and 3 Dentalium fragments	Primary
6	XX E 3.3, Fe-1	F11	Two pairs of pestles and a pair of mortars	De facto
7	XX E 3.1, Ec-1	E9	Three drilled bone artefacts	De facto/Primary
8	XX E 5.2, Ge-1	G11	Two basalt shaft straighteners	De facto
9	XX E 5.2, Ge-1	G11	Sickle (with inset bladelets), fragmentary bone haft, 21 lunates, 5 gazelle phalanges, 7 polished stones, 1 bladelet core, 1 fragmentary bone bead, and a fragmentary bone pendant	De facto
10	XX E/F 2.2, Sq. 3	I6	Complete gazelle hoof, with additional gazelle phalanx	De facto/Primary
11	XX E/H 4.1, Sq.5–6	G12	Pestle in mortar, mortar, pestle, and 2 grinding stones	De facto
12	XX F 3.1	D3	3 flaked chert axes	De facto
13	XX F 2.2	I5	Group of 2 burnt lunates, with several others nearby	De facto/Primary
14	XX G 1.3, Ca-2	M2	6 bone artefacts, incl. 4 drilled gazelle podial beads, 1 bone point and 1 worked bone fragment	Primary
15	XX H 3.1, Fa-1	K18	2 basalt grindstones with large lump of yellow ochre	De facto/Primary
16	XX H 3.1, Db-2	J16	3 flaked flint axes	De facto
17	XX K 3.1, Ca/b-1	J/K 25	Cluster of small stones, flaked stone tools and animal bone fragments	Secondary

as two or more artefacts which are complete, or which retain high use potential, found in close and patterned association, indicating purposeful placement. A prime example is Cluster 11 (Fig. 19B), where a pestle may have been either placed inside the mortar and both set down on the floor in a single action, or placed inside the mortar already stored on the floor. The basalt artefacts comprising Clusters 2 and 6 are analogous. They both feature distinctive arrangements of artefacts. Cluster 9 (Fig. 16D) consists of tools involved in a wide variety of tool maintenance, hunting, and gathering activities. This collection is so clearly defined that it appears to be the remnant of a storage container, long since disappeared. Many of the De facto clusters were stored away from main thoroughfares, at or near the edges of Structures 1 (e.g., Clusters 6, 8, 9, 11, 15, and 16), possibly where the superstructures were anchored to the stone wall bases to form secluded locations convenient for storage.

Clusters suspected to have resulted from in situ discard of materials involved in manufacturing activities or other tasks have been classified as *Primary clusters*. This category is epitomized by Clusters 4 and 14: piles of partly made and finished bone artefacts, an assortment of bone tools and Dentalium shell fragments (Cluster 5), and perhaps the cluster of Dentalium shells strewn around the base of a broken mortar (Cluster 3). The situation of most of the Primary refuse clusters, near the entrance to Structure 1 or immediately outside it in the case of Cluster 14, may have resulted from tasks carried out to take advantage of available light.

We are aware of the ambiguity involved in these groupings, particularly between the *De Facto* and *Primary refuse* categories. Many examples might simultaneously be allocated to both of these categories. For example, tool-sets such as mortars and pestles might have been used right where they were stored, or conversely, stored where they were repeatedly used. Indeed, we have felt unable to distinguish the two categories for Clusters 7, 10, 13, and 15 (Table 2).

The *Secondary refuse deposit* is represented solely by Cluster 17. This sharply demarcated heap of small stones and flint artefacts included much debris and debitage, and disarticulated animal bone fragments, and is unique for the site. It is delimited by a cleared passage or track to its west, just outside a short beak in the exterior wall of Structure 2. We have interpreted it as

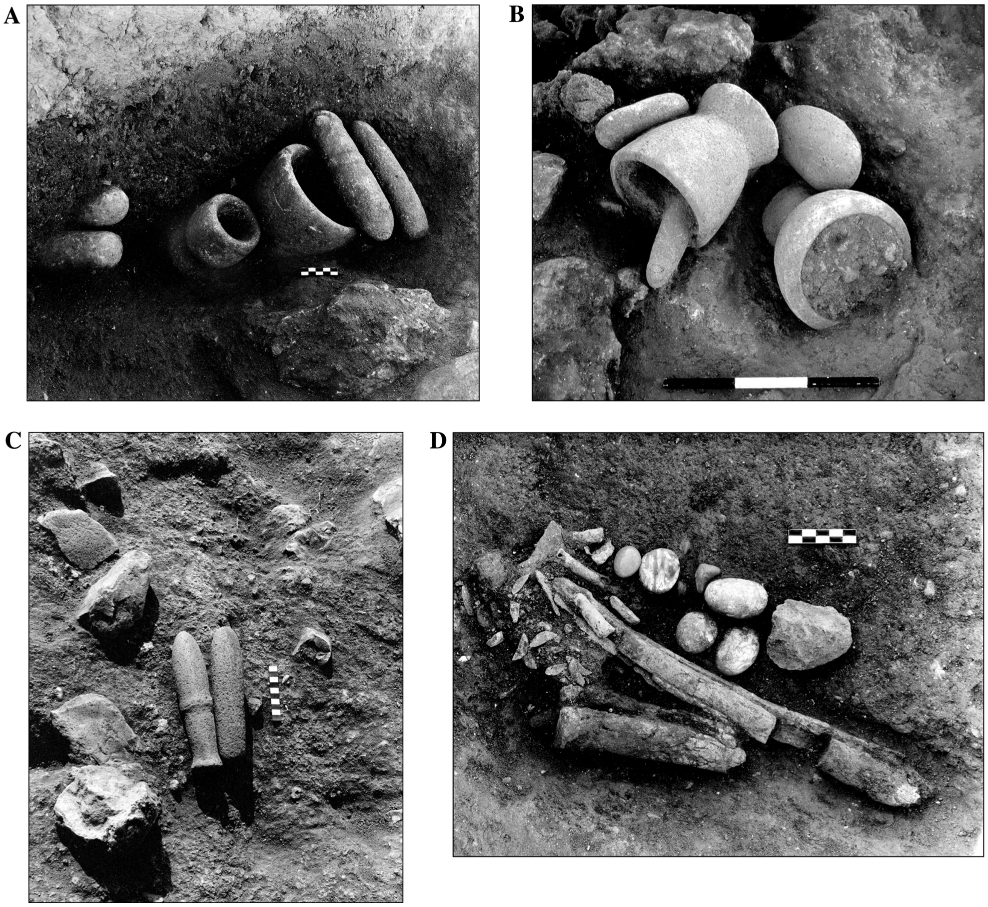


Fig. 19. (A) Cluster 6 in Structure 1: Two pairs of pestles and a pair of mortars. (B) Cluster 11 in Structure 1: Pestle in mortar, mortar, pestle, and 2 grinding stones. (C) Cluster 2, west of Structure 1: a pair of basalt pestles. (D) Cluster 9 in Structure 1 (tool cluster including flint-bladed sickle, gazelle phalanges, bone point and bead, lunates, core, and polished stones).

refuse dumped alongside the wall, adjacent to Structure 2. Cluster 17 conforms to the characteristics of limited artefactual inventory that Kent (1999) has described from secondary deposits in Kutse camps.

Along with our interpretation of 16 of the 17 clusters (94%) as in situ (primary or de facto) refuse on interior living floors, the situation of Cluster 17 immediately adjacent to Structure 2 contributes to our impression that clearance and dumping of refuse from the dwellings were unimportant practices.

Activity areas and task specialization

The concentration of carved siltstone and ochre fragments close to the trio of large carved slabs (F.2) in Structure 2 indicates it as primary refuse resulting from a spatially confined manufacturing event. At Wadi Hammeh 27 we have many overlapping sets of such discrete scatters as described in the previous section (e.g., Cluster 4). These localized intensive scatters tend to be 1–2 m^2 in area. There is some preference shown for different dwellings in which to perform certain craft activities. Most notably, 11 of the 17 artefact clusters occur in or around Structure 1, with only three from Structure 2, however, craft activities were carried out against the generalized backdrop of everyday domestic duties, rather than in specially allocated areas or purpose-built buildings. There is no evidence for the restriction of individual labor to specialized crafts, nor the location of such crafts in specialized architectural units. These important developments appear in the succeeding neolithic periods.

Artefact distributions in the peripheral plots XX M and XX N

Two small peripheral plots (XX M and XX N) were excavated to the east and south of the main excavation area in order to gauge the characteristics of the site near its margins. Plot XX M, located some 20 m south-east of the main excavation area, was a 2×1 m pit excavated to a depth of nearly 2 m. No architectural features were detected in it and artefact variety was curtailed with respect to the main area. The highest lithic density (in Locus 1.3) was a relatively modest 1413 lithics/m^3. Plot XX N was located over 52 m to the south of the main excavation area. It returned only a scant admixture of undiagnostic lithics, peaking at a density of 127/m^3. On the basis of these excavations, there is no additional evidence to support the existence of widely dispersed architectural units or peripheral refuse dumps at Wadi Hammeh 27.

Burnt artefacts: an informative 'smoking gun'

Little attention has hitherto been accorded to the burnt artefacts found strewn on the floors of Natufian and other Epipalaeolithic sites, yet this class of items may provide important signals about residential strategies. Ten hearths were identified among the dark sediments of the Phase I floors; all located inside the structures. Eight of them were bordered by stone surrounds; two others were evident as dark patches of stained sediment.

Fires were repeatedly lit on the carpet of artefacts and refuse, which explains the large quantities of flaked stone and bone artefacts that became incidentally burned. For example, up to 22% of a sample of flint debris in Structure 1 were burned (Fig. 20). Smaller proportions of debitage and retouched tool classes were burnt, but among these it is clear that higher frequencies occur for broken as opposed to complete items. The higher frequencies among the 'debris' categories resulted from the de novo production of chunks and chips through thermal shattering, and breakages among the pre-existing litter of blades and flakes were also caused by thermal action.

Flint derived locally from Wadi al-Hammeh was experimentally burned to replicate the range of changes observed in the Wadi Hammeh 27 assemblage (Edwards and Edwards, 1990). Whereas the Wadi Hammeh 27 knappers made attempts at heat treatment of flint, these were carried out on specially prepared cores, and cannot account for the range of material we are concerned with here, since thermal shock from direct burning results in the shattering of flint, rendering it useless for further work. The burnt retouched tools include examples of Helwan bladelets which bear silica sheen on their working edges; thus which had been used away from the site—to cut cereals in all likelihood—and then returned to it; discarded on the interior floors; and ultimately burned through their proximity to fireplaces. Some 7% of the bone tools were also burnt.

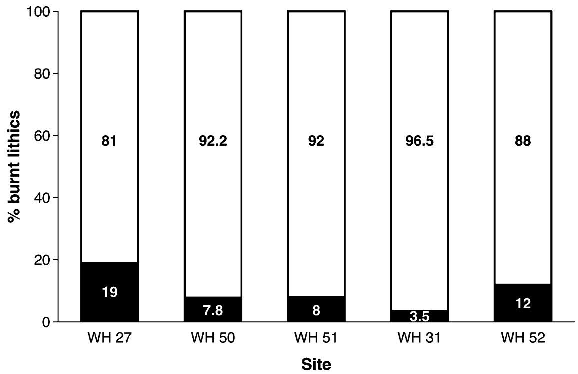
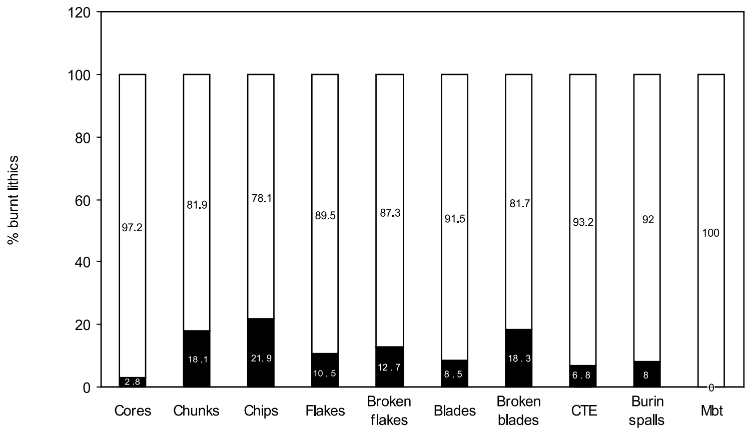


Fig. 21. Comparative frequencies of burnt lithics from Wadi Hammeh 27 and earlier Epipalaeolithic sites in Wadi al-Hammeh.



	Cores	Chunks	Chips	Flakes	Broken flakes	Blades	Broken blades	CTE	Burin spalls	Mbt
Total number of specimens	214	11,113	29,699	7,600	10,552	2,479	4,920	279	435	36

Fig. 20. Frequencies of burnt lithics at Wadi Hammeh 27, Phase 1.

Stratigraphic evidence demonstrates how areas of Wadi Hammeh 27 had been rebuilt over successive phases. The burnt material, derived from building fires over pre-existing artefact scatters, indicates that the inhabitants revisited the site many times within the lifespan of a single constructional phase. Furthermore, the comparative data from earlier Epipalaeolithic sites in Wadi al-Hammeh (Fig. 21) shows that the frequency of burnt material in Wadi Hammeh 27 is higher than the levels recorded for all of the smaller, earlier Epipalaeolithic sites of WH 50, WH 51, WH 31, and WH 52, dating between 20,000 and 14,500 years BP (Edwards et al., 1996). We postulate that this pattern developed due to the longer and more frequent occupation seasons that occurred in Natufian sites relative to most earlier Epipalaeolithic ones. It will be interesting to see if similar patterns emerge from other regional Epipalaeolithic sequences.

Summary of Wadi Hammeh 27's patterns of artefact discard

The refuse discarded at Wadi Hammeh 27 is remarkable for its abundance, with nearly half a million artefacts discarded on interior hut floors. There was no significant effort expended in removing garbage away from the residential dwellings, with only a single secondary deposit evident. Feature 7, located north of the wall of Structure 1, is also a possible candidate for secondary dump since it has high percentages of various artefact types concentrated within a small exterior area. However, these attributes are not really sufficient to unequivocally differentiate it from an exterior primary deposit.

Overall, 82% of refuse lies within the confines of the two major structures. The difference between interior and exterior deposits is evident not only in the quantity of material, but in the range and attributes of the artefact categories contained within them. For all categories of finds there are interior areas of markedly higher concentration around stone features and along the walls. There are also remains of discrete activity areas dispersed across the interior floors and intermingled with the general palimpsest of artefacts. Thus, the categories of primary and de facto refuse have become commingled.

By contrast, low frequencies of flaked stone and animal bone fragments occur in the exterior deposits, and there is a paucity of classes such as groundstone, bone tools, decorated objects, ochre, and human remains. For flaked stone there is an inverse relation between average weight and number, suggesting the irregular but periodic removal of larger flaked stone artefacts away from the central areas to the edge of the activity area, generally close to the walls, particularly Wall 1 in Structure 2. In Structure 2 the average weight is lower in the central areas than in peripheral areas near Wall 1.

The patterning and quantities of Natufian refuse at Wadi Hammeh 27 contrast with those of sedentary villagers. They more closely resemble the shorter-term aggregations of refuse left by mobile hunter-gatherers. Before these similarities and differences are more closely investigated, however, it remains for us to examine the general applicability of the Wadi Hammeh 27 case to the Natufian period by comparing the situation in contemporaneous sites. Thereafter a diachronic view is taken from the preceding Epipalaeolithic period to the succeeding Neolithic periods, in order to judge whether comprehensible patterns of long-term change characterize strategies of refuse disposal throughout the Levantine sequence.

Artefact discard patterns in other Natufian sites

Evaluating whether the lack of systematic refuse disposal was widespread in the Natufian requires an examination of artefact discard patterns in other large residential sites besides Wadi Hammeh 27. The three most pertinent comparisons with Wadi Hammeh 27 include Ain Mallaha (Eynan) at Lake Huleh in the northern Jordan Valley (Perrot, 1966), Hayonim Cave (Bar-Yosef and Goren, 1973), and the associated Hayonim Terrace site (Henry et al., 1981) in western Galilee. They are among the most similar sites to Wadi Hammeh 27 and they all contain Early Natufian horizons.

The Early Natufian phase at Mallaha contained subcircular dwellings (Valla, 1991, p. 112), semi-sunken and dry-built from limestone fragments in the main, except occasionally where a red lime mortar was used (in House 1). The oldest floor of the large House 131 is slightly concave (Valla, 1988, p. 283). Floors are not specially constructed but consist of compacted earth, and the fill layers above them consist of dark, homogenous sediments which are not easily differentiated. Several hearths are emplaced on interior floors. Postholes with stone surrounds were utilized to support the roofs. The site has three stratigraphic and constructional phases, including dwellings (such as Houses 131, and 62–73) which were rebuilt on the same spot (Valla, 1991, p. 112). Artefactually, Mallaha and Wadi Hammeh 27 share closely similar basalt industries, particularly in regard to the numbers of various tool categories (Wright, 1991), and are also similar in their incised rock art traditions (Noy, 1991).

The correspondences continue when we come to the distribution of refuse. Valla (1991, p. 116) describes how the fills in the dwellings of the Early and Late phases are "packed with objects," and in House 131 that the floors "are always congested with many flaked stone tools, bones, and other remains" (Valla, 1988, p. 284). House 131 has been published in most detail, and contains

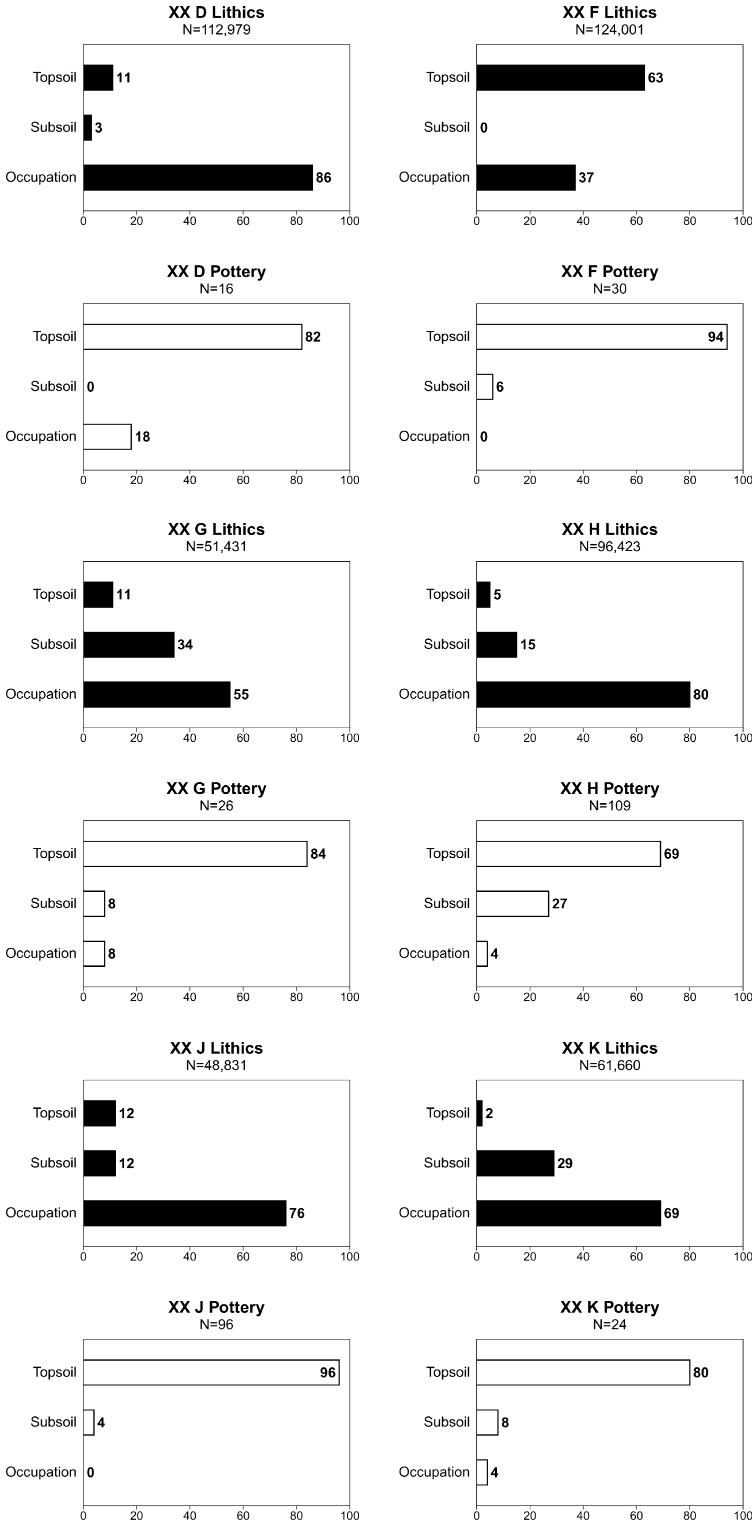


Fig. 22. Vertical movements of Natufian-period lithics and intrusive pottery at Wadi Hammeh 27, for Plots XX D, XX F, XXG, XX H, XX J, and XX K. In each case finds are assigned to one of three analytical stratigraphic units for Phase 1; namely Topsoil, Subsoil or Occupation deposit (cf. Fig. 3).

nearly 10,000 flaked stone tool fragments (Valla, 1988, p. 293). There represent all stages of core reduction, indicating that knapping took place in the dwelling. Skeletal remains of at least 13 taxa of animals and birds were strewn on the floor (Valla, 1988, p. 291). House 131 contains several large hearths that were the focus for numerous activities (Valla, 1991, p. 114). It has a high frequency of flint knives, quantities of bird bones, evidence for tool manufacture revealed by microliths and grooved stones, basalt pestles, and a polished and incised roe deer antler. Nearby lay fragments of limestone figurines, a human cranial fragment, a fragmentary dog mandible, and remains of a butchered gazelle.

Most of the refuse was found between the outer retaining wall and a concentric arc of inner postholes about a meter away. Two large clusters occur against the walls; the first containing 24 pebbles and 3 grooved stones; and the second comprising a large pile of basalt pestles, grinders, hammerstones, flaked stone tools, a bone point, and diverse faunal remains. Debris from bone tool manufacture lay in an arc close to the hut wall. Items included gazelle podial bones and the sawn-off proximal phalangeal bone fragments discarded as a by-product of their manufacture (Valla, 1988, p. 293). Artefact discard overall is heaviest around the walls, and near the entrance facing the available light, but sparsest towards the center of the dwelling. Rubbish-filled pits were dug into the fill levels over the floors, such as pit 113 which contains cinders and remains of tortoise, fish bones, and lentils. Valla (1991, p. 116) interprets these features as the perfunctory garbage disposal by the occupants of neighboring dwellings; stratigraphically though, they hail from later periods of occupation.

The amounts, type and distribution patterns of refuse within the Mallaha structures strikingly recalls those found at Wadi Hammeh 27. However, Valla is equivocal about the significance of the refuse quantities in Mallaha. Despite describing refuse quantities as voluminous, as outlined above, and referring to the "flaked stone, which, contrary to fauna, are superabundant in the shelter" (Valla, 1988, p. 293), elsewhere he argues that the amount of lithic refuse is not dense (Valla, 1991, p. 115), and that the number of cores (107) involved are so few that the possibility that they were regularly cleared out must be entertained. However, the core to total lithics ratio does not seem to us to be particularly unbalanced. Moreover, whether or not 10,000 stone artefacts are numerous or not is a matter of opinion, however, as discussed above, we regard it as representing a large mass of material per se. Valla also believes that the faunal scatter is thin due to consumption, but in this case carnivore scavenging (Davis, 1987, p. 26) and natural deterioration (Hill, 1979) might account for the disappearance of much of the cancellous bone tissue. Valla (1991, p. 112) considers the heavy presence of artefacts and refuse in the sediments above the floors as evidence of the back-filling of the structures with trash after they were abandoned. Nonetheless he also describes dense concentrations of in situ materials on the floors, as well as the vertical movement of small objects through the deposits. In the latter case we wonder whether an examination of artefact density versus vertical position would indicate that post-depositional agents have dislodged refuse from the floors.

Hayonim Cave is unusual in having a well-developed complex of circular stone dwellings within the cave's 230 m^2 interior. Like Ain Mallaha, and Wadi Hammeh 27, Hayonim Cave possesses several phases (I–V) of superimposed architectural units; in Hayonim's case they span the Early to Late Natufian periods (Bar-Yosef, 1991). Again, huge quantities of flaked stone refuse occur in each phase, ranging from ca. 10,000 pieces in Phase II to over 21,000 pieces in Phase V (Belfer-Cohen, 1988, p. 70). Belfer-Cohen (1988) has documented the distribution of several categories of artefacts, which are concentrated within the circular stone structures. Between Phases 1 and V, from 45.9 to 98.6% of cores are found inside the dwellings. For lunates the range is 69.1 to 97.3%; for burins, 65.4 to 98.1%; for *Dentalium* shells, 45.5 to 96.5%, for bone artefacts 46.4 to 100%, and for groundstone artefacts 58.6 to 96.6%.

For the heavier ground stone artefacts, some of which were grouped into specific caches, their "distribution demonstrated a clear inclination towards the eastern region of the cave, particularly along the walls" (Belfer-Cohen, 1988, pp. 278–279). Conversely, the interstitial loci between these dwellings are reported as being poor in finds (Belfer-Cohen, 1988, p. 282). At Hayonim, architecture is found in on the adjoining terrace as well as in the cave. On the terrace, Valla et al. (1991) have excavated architectural complexes into which human burials were excavated. Few details are forwarded about the density of refuse in the excavated zone, except for Feature 7, contiguous to the architectural complexes, which Valla et al. (1991, p. 98) interpret as a rubbish bin. Here, gazelle bones, an aurochs' femur, flaked stone tools, grinders, and hammer stones were crammed into an area of 1 m^2.

Summary of Natufian artefact distribution patterns

The artefact discard patterns of Natufian sites 'Ain Mallaha, Hayonim Cave, and Hayonim strongly resemble those of Wadi Hammeh 27. The points of similarity can be summarized as follows:

(a) Large quantities of refuse, particularly primary refuse, are present (consistently numbering in the thousands of fragments).
(b) Overlapping piles of in situ primary refuse derived from food processing and consumption and various

artefact production sequences, de facto refuse and even mortuary refuse are discarded inside dwellings
(c) Exterior spaces and peripheral areas remain relatively clear of refuse.
(d) Categories of refuse show overlapping but significantly different areas of distribution, with de facto refuse and heavy equipment stored near the walls, and the central space freer of debris.
(e) Little or no secondary dumping of refuse is apparent.
(f) Primary refuse includes numerous reduction sequences representing stages of manufacture of flaked stone, bone, and carved stone items.
(g) Task specialization occurs, but there is no significant evidence for the specialization of individual labor.

The Natufian residential structures were not necessarily fully enclosed dwellings like the later Neolithic houses. Their curvilinear stone walls are rarely complete; and conclusive evidence for continuous roofing over the larger dwellings is wanting. In any case, the residential units lack multiple rooms so that there was little possibility for rooms to be dedicated to the activities of specialists. Instead, the detritus of daily life coexisted with a range of enigmatic symbolic representations and even mortuary remains, or as François Valla (1991, p. 116) has well put it:

> "Activités techniques et symboliques s'y superposent comme elles se superposaient probablement dans l'esprit des Natoufiens."
>
> Technical and symbolic activities superpose themselves, just as they were probably superimposed in the Natufian spirit. (translated by PCE).

Artefact discard patterns before the Natufian period

Hamlets of the Natufian type do not occur in the earlier Epipalaeolithic period (dating from 20,000 years BP). Instead, the hearth generally served as the hub for activities in this earlier period, as a focus for artefacts and refuse. Over 60 sites from this period have been recorded, though relatively few have details about artefact and refuse distribution. Most sites are short-term campsites marked by shallow deposits, ranging in thickness from 0.1 to 0.3 m, and with materials extending in area over 20–200 m^2. Stone or pisé constructions occur rarely in this period and are mainly associated with hearths, pits, and postholes. Spatial studies so far carried out (e.g., Cauvin and Coqueugniot, 1988; Edwards et al., 1996; Goring-Morris, 1988; Nadel, 1995) indicate a common pattern of flaked stone, animal bone, and charcoal fragments accumulated densely about hearths. In Binford's terms (1983: 152–153), these campsites invariably contain 'drop' zones of discarded material but lack 'toss' zones or secondary dumps located on the fringes of the sites. The well-preserved Ohalo II, situated on Lake Tiberias, where brush huts can be discerned (Nadel, 1995, 2002) is a case in point. Material accumulated along the eastern edge of the site (Locus 10) has a similar range of contents as the refuse discarded on hut floors only 4–5 m away, and microdebitage analysis shows that primary knapping refuse is present over the entirety of the site (Nadel, 2000).

As Fletcher (1986) notes, Early Epipalaeolithic site areas of 20–200 m^2 are tiny in relation to the spatial needs of even small groups of hunter-gatherers. Thus, Hayden (1979, p. 138) demonstrated that camps of mobile bands in Central Australia extended to approximately 2000 m^2 in area in the case of Ngaralurutja, and to about 3000 m^2 in the case of Cundeelee (Hayden, 1979, p. 172), but very little of this space was marked by built features and would scarcely be recognized by archaeologists excavating subsequently. The excavator of Epipalaeolithic sites tends to find small spots of high artefact density (Edwards et al., 1996) and excavates accordingly. It is possible that we have hitherto entirely missed the 'donut'-shaped toss zones, or dumps in peripheral areas, but this seems less plausible than the likelihood that they exist rarely, if at all, in these sites.

The 'megasites' of the Azraq Basin in eastern Jordan (for example Jilat 6, 8, and 9, and Kharaneh IV; Garrard and Byrd, 1992, p. 59; Muheisen, 1988) epitomize the lack of emphasis on refuse relocation in this period. These immense middens of flaked stone and bone extend up to 21,500 m^2 in area, and contain detritus several meters thick, which accumulated over thousands of years.

The Natufian sites, then, exhibit a transitional mix of settlement characteristics typical of earlier and later periods. On the one hand, their architecture places them akin to the succeeding neolithic, but on the other, the piles of refuse in their interiors continue Epipalaeolithic practices—or, to borrow again from Rathje and Murphy (1992, p. 32) "To be sure, they sometimes tidied up their sleeping and activity areas, but that was about all." In the Natufian residence we see combined the Epipalaeolithic-style refuse dump within a Neolithic-style walled hut or compound.

Artefact discard patterns after the Natufian period

During the PPNA period and later in the PPNB period, houses and villages became more deliberately planned and elaborate, enabling the distinction between interior and exterior space to be more clearly demarcated. PPNA and PPNB site reports generally lack quantitative and precise spatial data concerning the material remains recovered in them, although Netiv

Hagdud provides an exception, since it is one of the few PPNA sites for which a comprehensive final report has appeared (Bar-Yosef and Gopher, 1997a). Likewise, artefact discards have been closely monitored at the late PPNB-equivalent site of Çatalhöyük (Hodder, 1999; Martin and Russell, 2000).

A rough comparison between the Natufian and the PPNA may be given by comparing Wadi Hammeh 27's average lithic density (1229 lithics/m^2) to Netiv Hagdud's 325 lithics/m^2 (Nadel, 1997, p. 71), suggesting a substantial reduction in artefact discard between the two periods. Spatially also, discard patterns begin to change in the PPNA period, with Netiv Hagdud heralding the process of relocation of refuse; not far, but at least to exterior contexts. Nadel concluded, "knapping debris was repeatedly swept from the houses," with house flints being "constantly moved, usually to the courtyards" (Nadel, 1997, p. 126). He notes that "The floors in the Upper Area are noteworthy for their low densities of waste," and that "In the Upper Area, density in the fills and the open areas is almost double that of the floors" (Nadel, 1997, p. 125). Netiv Hagdud still has caches and individual tools on interior floors (e.g., Locus 55 and Locus 8, Bar-Yosef and Gopher, 1997b, pp. 50–51, 56), but they are less common than in the Natufian sites and they contain fewer complete items.

Data from other sites are far less explicit, but it seems that cultural material is often recovered outside residential structures. At PPNA Gilgal I (Noy, 1989), low densities of artefacts were clustered on the floors (Noy, 1989, p. 12). The excavations demonstrate apparent spatial divisions of activities within House 11. At the PPNA-equivalent site of Qermez Dere in northern Iraq, it is noted that the floors of three excavated buildings were clean (Watkins et al., 1989, p. 20; Watkins, 1990). Continuing work at the Syrian site of Jerf al-Ahmar (D. Stordeur pers. comm. 2002, Stordeur et al., 1997) indicates a similar situation there too. Conversely, exterior areas were filled with trash at PPNA Hallan Çemi in south-eastern Turkey, where the upper three architectural phases feature curvilinear huts surrounding a circular open area. The latter was described as being packed with a dense array of animal bones, including several disarticulated carcasses, and fire-cracked pebbles and cobbles (Rosenberg, 1999, p. 26).

Nadel (1998, p. 9) makes an important distinction between Natufian and PPNA artefact discard practices. "In Natufian and other Epipalaeolithic sites, it is common to find the entire range of typological variability in each site, and even in each locus ... However, in PPNA cases, it is common to find typological differences between assemblages from contemporaneous loci at a site." Nadel (1998, p. 9) concludes: "It would seem that the differential distribution patterns of artefacts in PPNA sites represent patterns of human behavior that are distinct from preceding ones." The likelihood is that considerable curation and relocation of artefacts and refuse occurred in the PPNA.

The PPNB period in the Levant is represented by many more settlements than the preceding PPNA (Rollefson, 1992), and signals a significant increase in size of settlements in the second half of the ninth millennium BP. Kirkbride (1966, p. 17) noted that the five levels of replastered floors of Upper II Phase at PPNB Beidha were "very clean and scarcely a waste flake was found" as was the floor of Level III. A similar situation was encountered at 'Ain Ghazal (Rollefson pers. comm 1994). The prospect of regular cleaning of surfaces and the disposal of refuse to dumps could account for the observed decrease in artefact density over time and changes in the spatial distributions of artefacts. Goring-Morris (1991) notes that artefact densities in general at Kfar Hahoresh are generally low, with the exception of a pit fill that contained tens of thousands of lithics (Goring-Morris, 1991, p. 83). The pit's artefact density combined with large quantities of microdebitage indicates that it may be the refuse from the cleaning of a knapping floor elsewhere in the site. To the north, in the middle Euphrates valley in Syria, Coquegniot (1998, p. 111) reports that house floors in the early PPNB site of Dja'de al-Mughara held little detritus, and were nearly always clean of substantial archaeological materials. Further afield in Turkey, Çatalhöyük shows separation of function within individual houses, and a complex cycling of materials through interior and exterior spaces. Building 17 in Level IX, for example, had a 'dirty' corner with domestic trash; whereas other parts of the interior were kept clean (Hodder, 1999, p. 5). Flotation of the deposits yielded minute fragments of animal bone, shell, and obsidian (Martin and Russell, 2000, p. 61), indicating the practice of frequent sweeping. The external spaces between houses featured middens into which household refuse was repeatedly dumped over extended periods.

One must also consider, as Danielle Stordeur (pers. comm. 2002) has observed, that Natufian huts were laid with simple earthen floors into which refuse could be trampled on a daily basis. By the PPNB period however, houses were routinely furnished with hard, plastered floors which formed impenetrable bases to the dwellings, such as at El-Kowm 2 (Stordeur et al., 2000, p. 39). In these settlements, it was no longer possible to ignore accumulations or refuse and artefacts underfoot, particularly the razor-sharp products of lithic reduction, without suffering significant discomfort. From published data we have calculated lithic densities at several sites (Fig. 23), While these figures are few and must be used with caution, they do, so far, reveal a consistent trend to decrease in artefact densities from the Natufian period through the PPNA and PPNB periods

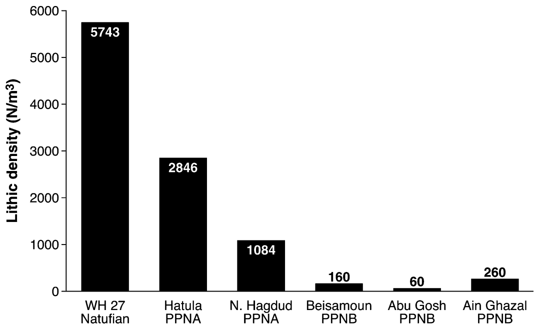


Fig. 23. Comparative lithic densities in sites from Epipalaeolithic to PPNB periods: Hatoula (Lechevallier and Ronen, 1985), Netiv Hagdud (Bar-Yosef et al., 1991), Beisamoun (Lechevallier, 1978a, p. 153), Abu Gosh, (Lechevallier, 1978b, p. 41; 1978c, p. 12), and Ain Ghazal (Rollefson et al., 1992, pp. 444–445, 454–455).

Wadi Hammeh 27 in the light of the ethnographic record and the recent past

The mélanges of artefacts which occur in Natufian sites are rarely echoed in the ethnographic present. For example, it is has been concluded that when people prepare to abandon their settlements for the final time, they may be more tolerant of refuse accumulating in areas which would normally be kept clear if reoccupation is on the cards (Schiffer, 1976, pp. 33–34). Based on this premise alone, Wadi Hammeh 27 and should represent a final-abandonment assemblage, when we have evidence that consistent and repeated occupations contributed to its discard patterning.

Baker (1975, p. 11) has concluded that "it seems reasonable to suggest that an item will be placed in storage only when return to an activity area is anticipated," in which case the caching of heavy gear at Wadi Hammeh 27 against walls and in darkened corners argues for planned returns. Many of the caches are located next to walls, as if stored away; others are located near to the entrance of Structure 1, as if left at the work station. The practice of storing gear is documented in many contemporary and historic sites and it has been observed that cached items and larger tools tend to be placed near the fringes of structures, away from central thoroughfares (Binford, 1983, pp. 183–184; Seymour and Schiffer, 1987, p. 578), to be misplaced or left behind when the site is evacuated (cf. Binford, 1983, p. 184).

Size-dependant sorting of refuse by human activity has been documented in a number of ethnographic studies (Binford, 1978; Clark, 1986; O'Connell, 1987; Spurling and Hayden, 1984; Yellen, 1977), through he intentional discard of large debris in secondary dumps. On these grounds, we should consider the Natufian pattern as reminiscent of short-term sites, in the order of a few days or weeks; however other considerations (cited above) lead us to believe that Natufian occupations were considerably longer and probably seasonal in extent. To complicate matters, brushing or sweeping can result in the displacement of large objects to peripheral zones (Murray, 1980; O'Connell, 1987; Schiffer, 1987, p. 58). Both methods of refuse dispersal result in many smaller lithics becoming lost and left behind in the central activity (Clark, 1986; Nadel, 2000; Simms, 1988; Stevenson, 1985). At Wadi Hammeh 27, we have a curious situation in which larger items are removed or placed against the walls, but we are still left with a strong representation of refuse deposited in the central activity area. We suggest that this combination of patterns results from the dissonant time periods under study—very short in the ethnographic cases but far longer for the Natufian archaeological cases. In consequence, the traces of numerous activities have become overprinted on a single stratigraphic horizon, which has lead to a blurring of the patterns stemming from many occupational cycles.

Our diachronic generalizations on refuse disposal in the Levant appear to form a robust trend, commanding at present strong empirical support. From our series of ethnographic referents, we know that cases exist of complex, semi-sedentary hunter-gatherers such as the Nootka of the North-West Pacific Coast, who lived amongst prodigious dumps of refuse for long periods. In their written recollections, we see late 18th century European visitors to the North-West Pacific Coast unable to contain their distaste at the condition of Nootka houses. Cook (1784, p. 317) described them as being as "filthy as hog-sties; everything in and about them stinking of filth, train-oil and smoke." The Spaniard Moziño (1792, p. 19), who was held captive at Nootka Sound gave detailed descriptions of mounds of seafood left to rot in occupied houses. Finally, King (in Beaglehole, 1967, p. 1409; emphasis added) concludes with the judgment: "... to sum up all, they are the worst *adaptd* & filthiest houses that can possibly be in this World"—a useful example of the subjectivism an observer may display when faced with social norms far removed from his own; not to mention a useful warning of the danger in viewing human behavior simply as a set of activities seeking to attain an idealized state of social adaptiveness.

Conclusions

Generally, we find dramatic contrasts between Natufian and ethnographic case studies, though occasional parallels such as with the Nootka villages occur. Natufian dwellings are smothered in a rich farrago of refuse composed of food scraps, tool-making debris, useable tool and ornament clusters, and even ritually important items such as human skeletal remains. These dense amalgams commonly include thousands, tens of thousands—and in the case of Wadi Hammeh 27—hundreds of thousands of items. Natufian refuse patterns are more reminiscent of the 'drop' zones of short-term, mobile hunter-gatherers than they are of the secondary refuse disposal practices of sedentary villagers. But the patterns are many and interleaved, hinting at a multifaceted residential schedule, which we have as yet scarcely penetrated. Thus, the debate over Natufian settlement strategies can profitably move on from a facile dichotomization into sedentary or mobile (Perlès and Phillips, 1991) to a more nuanced appreciation of residential scheduling; one of lengthy base-camp stays and intermittent evacuations. To this extent our conclusions from refuse behavior can be accommodated with the data from seasonal fauna; which indicate multiple seasonal visits at Wadi Hammeh 27 and other large Natufian sites. However, we stress that the two lines of inquiry remain on parallel and separate tracks. That is, while our analyses of artefact discards suggest seasonal visits, they have no means to specify *which* seasons are involved.

In the Levantine sequence we have outlined, there is a clear gradient of change through time, towards higher curation rates and more secondary refuse disposal. The gradient is also apparently somewhat punctuated, rather than gradual, with noticeable shifts in pattern corresponding to the advent of the Natufian, PPNA and PPNB periods. We conclude that human communities in the Natufian period had not tailored their indifferent household sanitation practices to the long-term requirements of sedentary living. Elementary efforts at refuse disposal begin in the succeeding (PPNA) period, and consistent garbage cycling may have began to be seen as a sanitary necessity for the effective maintenance of the large PPNB villages. Although more precise information is needed to clarify the situation for the large PPNB sites, our interpretation of the diachronic trends in refuse behavior in the prehistoric Levant runs parallel (though independently concluded) to very similar conclusions previously expressed by Nadel (2003, p. 43). We can conclude by recalling Kirkbride (1966, p. 17); who portrayed PPNB house interiors as "very clean," with "scarcely a waste flake to be found"—the outcome of four millennia of practice at house-keeping.

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