

01 **Demography and Storage Systems During**
02 **the Southern Levantine Neolithic**
03 **Demographic Transition**
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07 **Ian Kuijt**
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13 **Abstract** Despite its importance in understanding the forager–farmer transition,
14 remarkably little recent research has explored the role of food storage and changes
15 in food production as a foundation for the NDT. Drawing on data from the southern
16 Levantine Neolithic, in this chapter I make two arguments. First, while significant,
17 the NDT in the southern Levant was gradual, and it appears that the major period
18 of growth occurred ca. 1,200 years after the appearance of domesticated plants.
19 Second, rather than focusing on plant domestication as the defining catalyst of the
20 NDT, these data highlight the importance of food storage based on wild foods that
21 facilitated greater sedentism. In the southern Levant, there is clear evidence that the
22 subsistence and nutritional foundation for the NDT appeared several thousand years
23 before the appearance of domesticated plants.
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25 **Keywords** Food Storage · Pottery Neolithic Periods · Natufian
26

27 *...whenever resources are highly seasonal, sedentarism and large-scale storage imply*
28 *each other: storage brings forth sedentarism, and sedentarism presupposes storage* (Testart
29 1982: 524).
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31 **The Near Eastern Neolithic Demographic Transition: Exploring**
32 **Changes in Demography and Food Storage**
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35 The transition in food production from collecting wild resource to reliance on farm-
36 ing of domesticated plants and animals represents the major social and economic
37 transition in human prehistory. While it has long been noted that population in-
38 creases were linked to the Neolithic revolution it is only relatively recently that
39 direct explicit research has focused on demography. Focused on north and cen-
40 tral Europe, Bocquet-Appel (2002) argues that European Mesolithic and Neolithic
41 cemeteries illustrates a two-phase demographic transition in what is now known
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01 as the Neolithic Demographic Transition (NDT for short). In the initial phase of
02 the Mesolithic (or Epipaleolithic, and more specifically Early and Late Natufian, if
03 one is focusing on the Levant) to Neolithic transition we see a shift from a quasi-
04 homeostatic equilibrium in birth rates to a much higher birth rate. Bocquet-Appel
05 hypothesizes that this was linked to improved dietary conditions with the intro-
06 duction of grains, and eventually, the adoption of dairy products (Bocquet-Appel
07 2002:647). It is hypothesized that after 500–1,100 years an increase in mortality
08 would cause a return to quasi-stationary equilibrium. It is important to note that the
09 highest birth rate (from his samples this represents at rate of 1.24%) occurs between
10 300 and 800 years after the appearance of domesticates.

11 Other demographic studies have sought to expand our understanding into new
12 geographical areas and different topics, directing new attention to the demographic
13 links to settlement systems (Bandy 2004), and changes in agricultural labor and
14 subsistence (Eshed et al. 2004). Other studies of settlement and mortuary changes
15 in a mixture of primary and secondary domestication contexts in the Americas
16 (see Bandy 2006; Bocquet-Appel and Naji 2006), and European case studies (e.g.,
17 Bocquet-Appel 2002) based on secondary diffused Neolithic economic and tech-
18 nological packages, have yet to resolve if the magnitude and overall timing of the
19 NDT is the same in case studies characterized by the diffusion of farming into new
20 regions compared to regions of primary agricultural origins such as the Near East.

21 As noted at the start of this chapter, Testart (1982) has forcefully argued that food
22 storage, population growth, sedentism and social inequality are often interlinked.
23 As outlined elsewhere (Bellwood 2005, Bar-Yosef and Meadow 1995; Read and
24 Le Blanc 2003), with greater sedentism, increased birth rates and increased quality
25 and quantity of domesticated foods we see the foundation for dramatic social and
26 cultural developments.

27 Additional research (Stopp 2002; Ingold 1982) has shed new light on the use of
28 storage among hunter-gatherers: storage is both compatible with nomadic move-
29 ment, and in some contexts, actually furthers highly mobile settlement systems.
30 While Testart (1982) is largely correct in identifying the potential social and eco-
31 nomic byproducts of the use of storage systems, other researchers (Hayden 1982;
32 Ingold 1982:531) convincingly argued that in some situations permanent settlement
33 with agriculturalists, tied to intensive storage, still requires women to move from
34 residential to field areas. From this perspective food storage does not always result
35 in reduced physical stress during the seasons where active fieldwork and harvesting
36 are required, although clearly it does result in an overall decrease. While there is
37 disagreement as to the links between food storage and population growth among
38 researchers (e.g., Hayden 1981; Ingold 1983; Testart 1982), there is general agree-
39 ment that while food storage may not directly result in population growth, significant
40 population growth is largely predicated on intensive agriculture and food storage.

41 This chapter is focused on the unexplored intersection of Neolithic food storage
42 and demography, and is grounded on the assumption that the development of stor-
43 age technologies is critical aspect of population growth, such as witnessed with the
44 NDT. Focusing on the southern Levant with the gradual transition from collector-
45 foragers to foraging-farming economies, I examine current modeling of the NDT

01 from two archaeological perspectives: population growth, as seen in through the
02 lens of settlement size, and shifts in subsistence strategies, as reflected in changes
03 in storage practices. In the first section I explore some of the interrelationships be-
04 tween settlement practices and demographic increases. This analysis suggests that
05 while there was a concomitant increase in the size and nature of settlements with the
06 initial appearance of domesticated plants and animals, there was also a much greater
07 increase in settlement size some 1,500 years after the first appearance of domesti-
08 cates. These results highlight that the NDT does not appear to be as pronounced
09 in the primary domestication context of the Near East compared to contexts where
10 population migration and diffusion of agriculture occurred. In the second half of
11 the chapter I present available data for changing storage practices before and during
12 the NDT, and discuss some of the possible links between economic intensification,
13 sedentism and food storage. Drawing upon these data, I develop the argument that
14 Epipaleolithic–Neolithic storage practices and settlement data illustrate a higher de-
15 gree of pre-agricultural sedentism than seen in the European Mesolithic–Neolithic
16 transition. Collectively, I argue that to understand the southern Levantine NDT it is
17 necessary for us to understand how food storage created the conditions for reduced
18 residential mobility, increased access and control over plant foods throughout the
19 year and ultimately led to reduced stress for females and increased birth rates.

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26 **Neolithic Settlement Size, Population Levels and Storage: 27 Methodological Considerations**

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Before proceeding further it is necessary to briefly address some methodological complexities of reconstructing settlement systems, demographic patterns and storage practices. Recent research (Eshed et al. 2004; Hershkovitz and Gopher 1990; Henry 2002; Kuijt 2000) has explored a number of thematic and methodological questions related to Neolithic demographic change. Archaeologists often follow one of two methodological pathways when looking at demography: study of mortuary data, and population estimates based on settlement size and architectural density. Both approaches have strengths and weaknesses. As noted by Berner and Schultz (2004), demographic reconstruction based on skeletal material and death rates requires a series of assumptions. Similarly, site-level demographic reconstruction based on architectural data requires estimates of the size of settlements, the amount of time the settlement was occupied, and if the architectural remains at a settlement reflect a single contemporaneous occupation or multiple occupations in different points within a single phase (see Banning and Byrd 1987, 1989; Bienert et al. 2004:168–169).

Drawing on ethnographies attuned to the use of space, archaeologists (e.g., Cessford 2005; Henry 2002; Kuijt 2000) have employed architectural data sets to better understand Neolithic demographic change. This approach is complicated by several operational assumptions: (1) that the type and density of structures in excavated areas are a representative sample; (2) that the horizontal extent of cultural

01 materials for each site represents the maximum extent of the site while occupied;
02 (3) that the occupation density is constant in all areas of the site; and, (4) the so-
03 cial and economic systems for sites from different periods are similar enough to
04 20th century ethnographic or mortuary studies to permit reasonable comparisons.
05 Population reconstruction based on settlement data generally requires acceptance of
06 these assumptions, but such analysis is complicated by the fact that not all parts of
07 settlement were always occupied at the same time (see Akkermans et al. 2006; Kuijt
08 2004).

09 As argued elsewhere (Akkermans et al. 2006; Bienert et al. 2004:168–9; Rollef-
10 son and Köhler-Rollefson 1989:79), most structures/areas of settlements were prob-
11 ably occupied at different temporal points (perhaps separated by tens or hundreds of
12 years) within a single phase. While arguably these are contemporary in archaeolog-
13 ical time, in reality the occupants would not have known each other and the human
14 processes that produced materials residues were largely unconnected. Researchers
15 also debate how site area and architectural density might have been linked to pop-
16 ulation density (see Cessford 2005; Garfinkel and Miller 2002: 258; Kuijt 2004
17 for a range of estimates). Such debate is understandable as there is considerable
18 variation in the ethnographic estimates provided by the researchers (e.g., Kramer
19 1982; van Beek 1982; Watson 1979) used to model prehistoric population levels.
20 Based on the ethnographic and ethnoarchaeological research of van Beek (1982),
21 Kramer (1982) and Watson (1979), researchers have developed a range of estimates
22 on the basis of the amount of floor space/person, or the number of people living
23 in a 1 ha settlement. For example, working backward from how many people lived
24 around 1 ha of land, the resulting estimates vary between 97 and 83 people per ha
25 (Kramer 1982 and Watson 1979) to 294 people per ha (van Beek 1982). Choosing
26 the larger of these estimates, many researchers (including Kuijt 2000, Table 2) em-
27 ploy van Beek's (1982) estimates to generate population estimates. In the absence
28 of any clear consensus, it is probably best to employ Kramer's (1982) and Watson's
29 (1979) more conservative, lower estimates, for developing population estimates. It
30 is, moreover, probably better to employ such data as comparative estimates, rather
31 than as straightforward reference for past populations (see Akkermans et al. 2006;
32 Hassan 1981; Hershkovitz and Gopher 1990 for further discussion).

33 Along similar lines it must be recognized that there are numerous complexities in
34 identifying the material manifestations of different types of storage in the past (see
35 Ingold 1983; Stopp 2002; Testart 1982). The reconstruction of past storage through
36 archaeological data is both highly complex, and given that it deals with materials
37 that do not always preserve well in the archeological record, our archaeological
38 understanding at some level will always remain incomplete. Our confidence in in-
39 terpreting select features as being used for storage, as well as the scale of storage,
40 is tempered by several constraints. First, due to differential preservation not all food
41 storage can be identified in the archaeological record. While not random, direct
42 preservation of foods through burning or other agents of conservation, is inconsis-
43 tent and unlikely to be representative of the entire range of foods used and stored
44 in a prehistoric economy. Second, ethnographic accounts of hunter-gatherers and
45 farmers provide evidence for a wide range of storage practices, many of which have

01 no or few material manifestations, and occur off site (Stopp 2002). It is important to
02 acknowledge that at times storage is largely untraceable even with the most sensitive
03 and sophisticated archaeological research. Third, while we can use ethnography to
04 help us understand the past use of architectural features, it is possible that Neolithic
05 storage practices differed from the comparative case. Much of our archaeological
06 understanding of past storage practices is based on preserved features and struc-
07 tures that are empty, rather than direct evidence such as the recovery of burned
08 paleobotanical remains from inside of features. Researchers are often left with no
09 alternative but to develop circumstantial arguments that specific features were used
10 for food storage rather than on general storage of goods.

11 While recognizing the methodological complications in reconstructing storage
12 practices, this does not negate the importance of addressing this issue. If one accepts,
13 as I do, that subsistence intensification, population growth and the emergence of
14 new forms of property are interrelated, then it is critical that we seek to understand
15 changes in Neolithic storage systems. In cases where we have preserved remains,
16 it is possible to generalize to the use of wider storage technologies and practices.¹
17 Let us now turn the archaeological evidence for settlement change and food storage
18 before, during and after the NDT.

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21 **The Levantine NDT: What Does the Settlement Data Tell Us?**

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23 How does southern Levantine Neolithic settlement data help us understand demo-
24 graphic change with the forager–farmer transition in general, and the NDT model in
25 specific (Bocquet-Appel 2002)? To what extent do we find a corresponding increase
26 in the size of settlements and density of architecture in the period directly after
27 the appearance of domesticated plants and animals? Working on the assumption
28 that the largest settlements provide a relative idea of changing demographic pat-
29 terns through time, several researchers note that the overall Neolithic settlement
30 pattern illustrates considerable expansion in communities from the period of 11,500
31 to ca. 8,400/8,000 cal BP and a drastic reduction in the size of settlements after this
32 point.² As one would expect, there is a significant increase in the size of settlements

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35 ¹ My aim here is to examine available evidence for storage with the understanding that while much
36 of it is related to food storage, there is the distinct possibility that some of these features and struc-
37 tures were used for other forms of storage. Just as importantly, this recognizes that archaeologists
38 have only a limited understanding of the possible role of the range and importance of storage types
39 with mobile foragers and early agriculturalists.

40 ² The major phases of the Pre-Pottery Neolithic period, include the first semi-sedentary collector-
41 agricultural villages in the Pre-Pottery Neolithic A (PPNA) appearing between ca. 11,500 and
42 10,500 cal. BP., the formation of established agricultural villages of the Middle Pre-Pottery Neo-
43 lithic B (MPPNB) between ca. 10,500 and 9,500 cal. BP., and the emergence of large aggregate
44 villages of the Late Pre-Pottery Neolithic B period (LPPNB) dating to between ca. 9,500 and
45 8,700 cal. BP. The Pre-Pottery Neolithic C period (PPNC) is viewed as a transitional phase be-
tween the LPPNB and Pottery Neolithic period at select sites. It remains unresolved, however,
if PPNC was a regional or local phenomenon, or if it is significantly different, both materially

01 directly after the domestication of plants. For example, as seen in Fig. 1, the five
 02 largest known Late Natufian settlements are each approximately .2 ha. In contrast,
 03 the largest PPNA period settlements averaged over 1 ha. With the appearance of do-
 04 mesticated plants and some animals, we find that the largest known MPPNB period
 05 settlements increased in area to nearly 4.5–5 ha. Interestingly, a second and much
 06 more significant increase is seen in LPPNB settlements such as Basta, ‘Ain Ghazal,
 07 which were between 10 and 14 ha in size (Fig. 1). Most of these villages appear to
 08 have lasted for only 3–400 years, or drawing on the research of Eshed et al. (2004),
 09 probably between 10 and 14 generations. Our understanding of the period in which
 10 these villages were abandoned, termed the PPNC period, remains poor. Excavations
 11 at PPNC components of sites, including Atlit-Yam (Galili et al. 1993), ‘Ain Ghazal
 12 (Rollefson and Köhler-Rollefson 1989) and possibly Es-Sifiya (Mahasneh and Bi-
 13 enert 2000; Mahasneh and Gebel 1999), suggest that while some settlements may
 14 have become smaller in size and population, other settlements (such as Es-Sifiya)
 15 may have stayed at approximately the same size as LPPNB settlements, and were
 16 characterized by a high density of residential architecture (Figs. 1 and 2).

17 When we contrast the NDT model of Bocquet-Appel (2002) and the settlement
 18 data from the southern Levant we see some interesting, if not unexpected, patterns
 19 (Fig. 3).

20 Looking at the timing of these events several observations and queries can
 21 be made:

- 22 1. In contrast to the European examples, the pre-agricultural context of the Natufian
 23 and PPNA reflect a much higher degree of sedentism, and much larger settle-
 24 ments. Does this data support that such developments were only possible in a
 25 high-resource density region, where people could live well in small villages and
 26 rely on wild plants and animals in a relatively local catchment area?
- 27 2. There is a clear increase in the size of settlements, density of structures and the
 28 number of burials in the MPPNB immediately after the appearance of domes-
 29 ticated plants and animals. This would appear to be a physical by-product of
 30 increased sedentism, increased birth rate and subsistence intensification.
- 31 3. While MPPNB sites were considerably larger than PPNA sites, they were much
 32 smaller than those of the LPPNB. LPPNB villages were 3–4 times larger, with
 33 much greater architectural density. What were the social and economic factors
 34 that contributed toward the remarkable growth of LPPNB settlements?
- 35 4. The emergence of the large LPPNB villages occurs 1,000–1,500 years after the
 36 first appearances of domesticated plants and animals in the Levant. If the emer-
 37 gence of LPPNB villages was related to the NDT, then how do we explain the
 38 time lag between domestication of plants and animals and emerging villages?
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 42 and culturally, from other contemporary settlements. The length of this period remains unclear.
 43 The Pottery Neolithic is subdivided into two major sub-phases (with local adaptations) generally
 44 known as the Pottery Neolithic A and Pottery Neolithic B periods. Readers are directed to Gopher
 45 and Gopher (1993) for detailed discussion of the Pottery Neolithic period.

Demography and Storage Systems

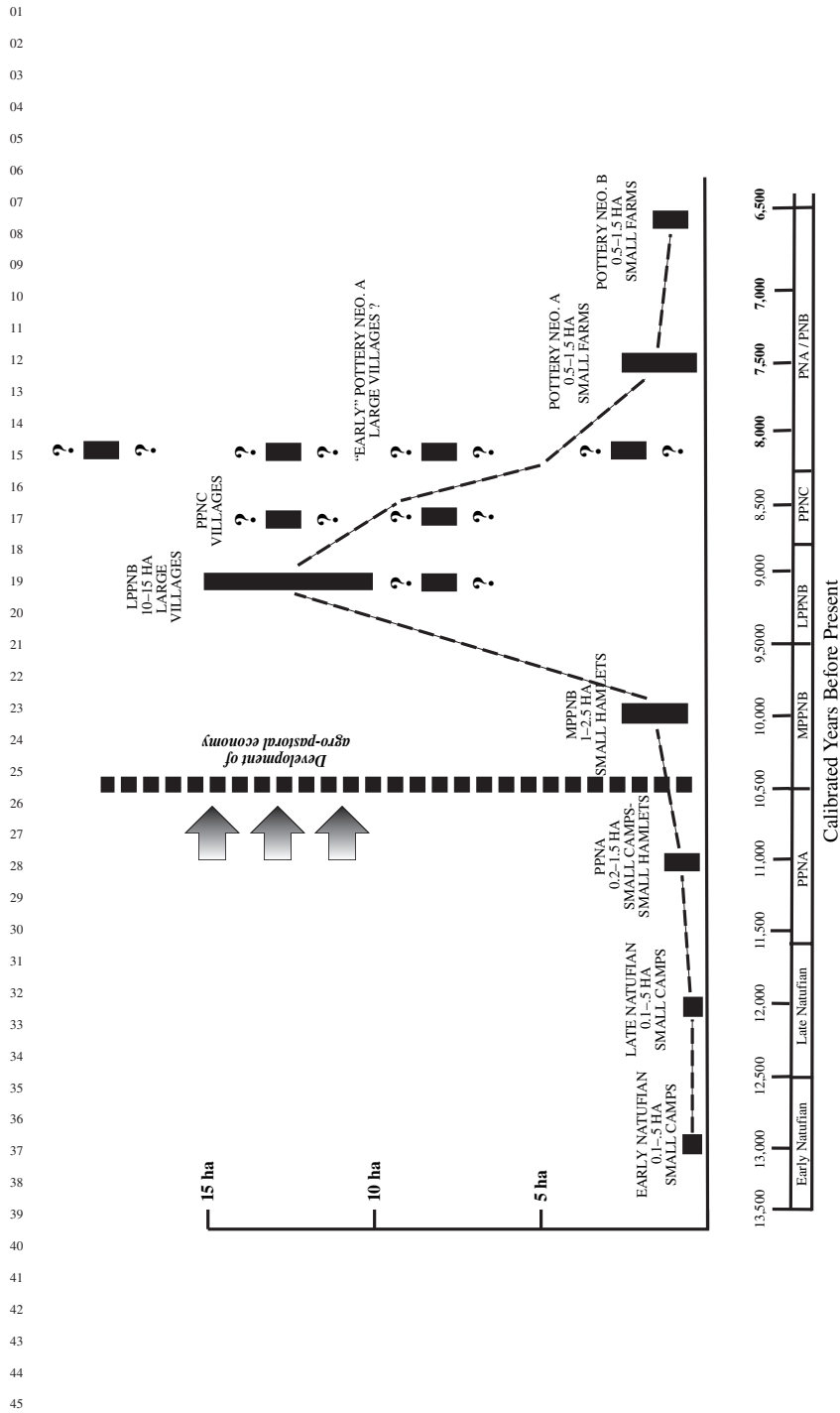
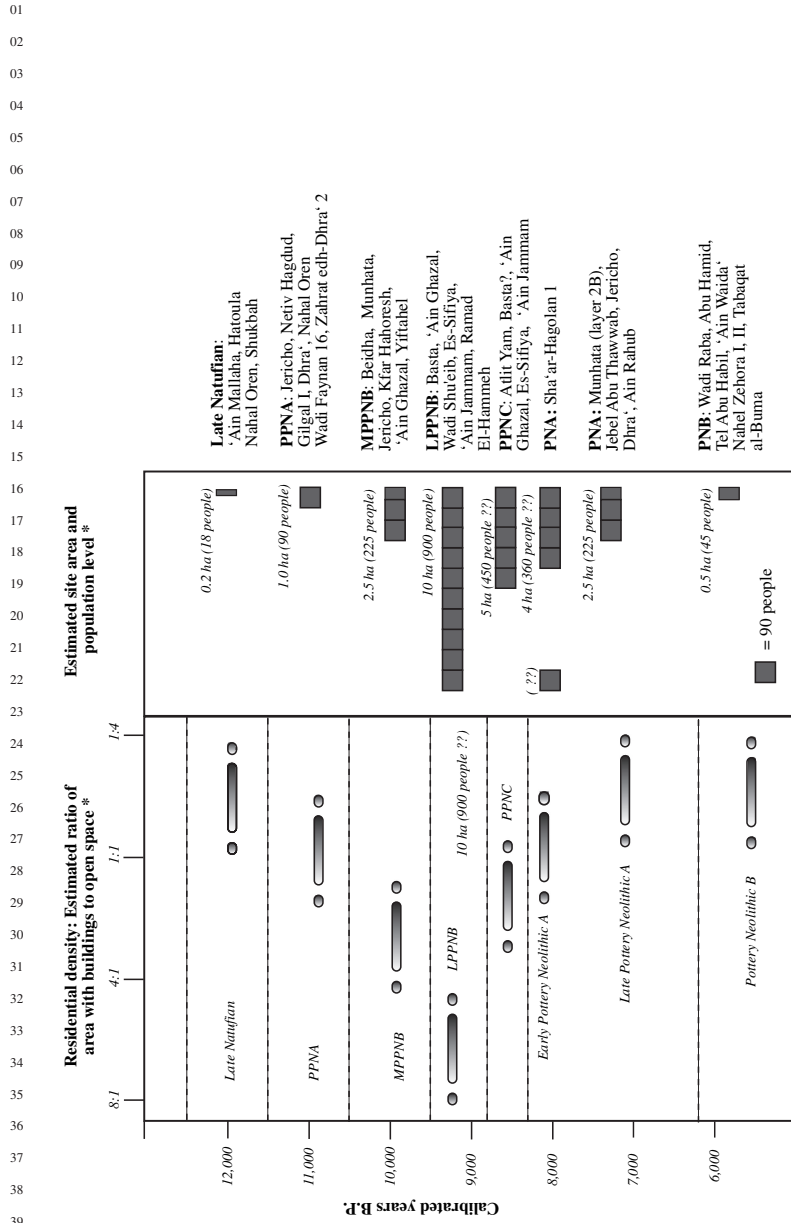


Fig. 1 Estimated changes in the horizontal extent of open air Late Neolithic settlements located in the Mediterranean vegetative zone of the southern Levant. These data are based on the mean size of the largest sites by period (Kuijt 2001). Despite considerable field research over the last 10 years, variation in the size of Late Pre-Pottery and Pottery Neolithic villages remains unclear



* These estimates are based on Kuijt 2000, Kuijt and Goring-Morris 2002, and Gopher and Gophna 1993. Due to differences in archaeological visibility and research history, especially for the Pottery Neolithic periods, these must be treated as estimates.

Fig. 2 Estimated changes in community housing in open air Late Natufian through Pottery Neolithic settlements located in the Mediterranean vegetative zone of the south-central Levant. The population estimates are based on rates developed from Kramer (1982:162) and Watson (1979:35-47)

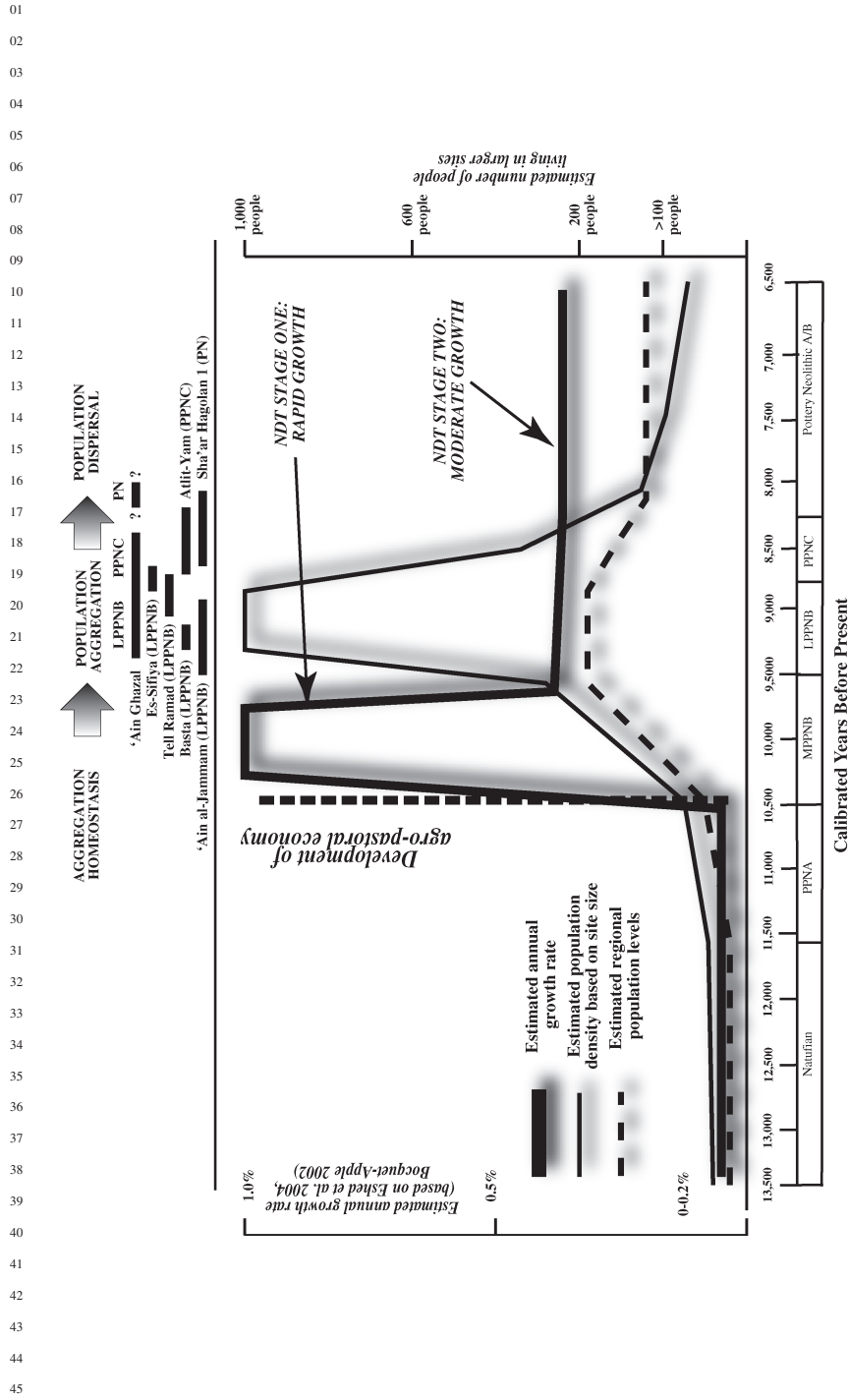
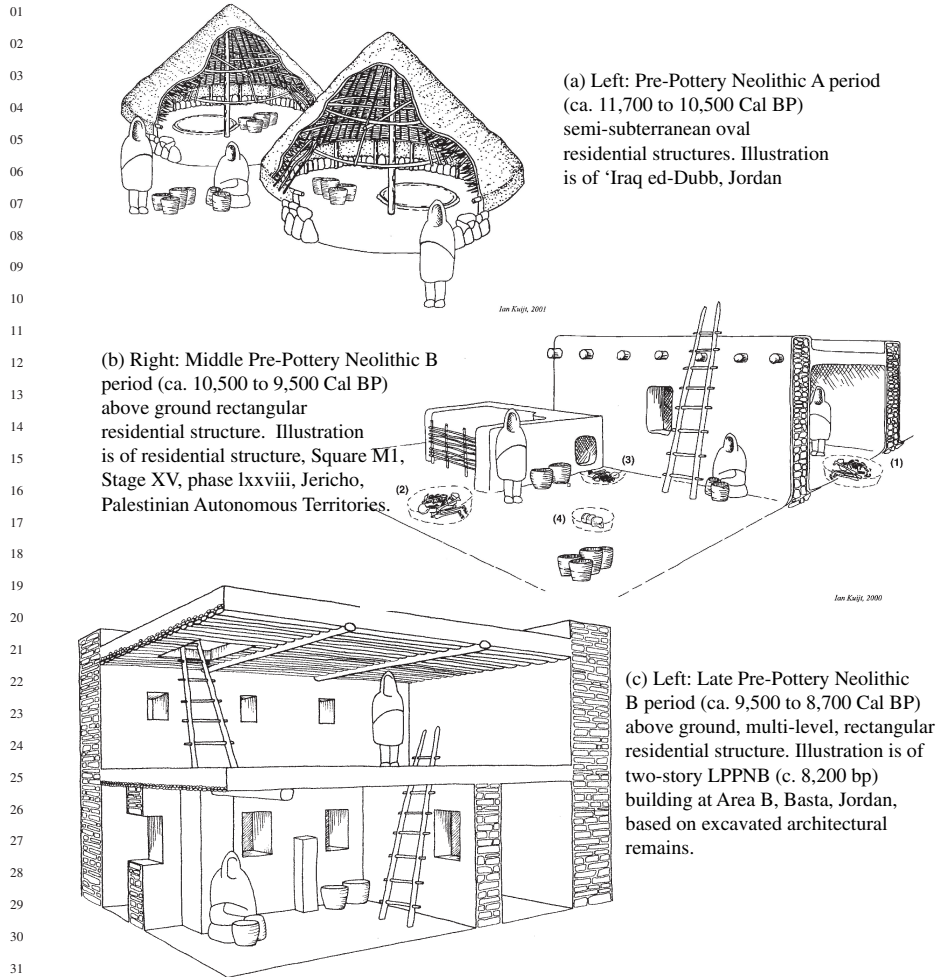


Fig. 3 Comparison of the estimated demographic growth pattern with the onset of agriculture and number of people living in large settlements (based on Fig. 2). Based on Eshed et al. (2004) and Bocquet-Appel (2002)

- 01 5. The dramatic increase in the density and size of LPPNB sites occurs just when
 02 Bocquet-Appel's (2002) model predicts a return to quasi-stationary equilibrium
 03 of birth rates. It is not clear that these are related events. If not, how are we to
 04 explain the patterning?
- 05 6. The large village systems of the LPPNB/PN were abandoned approximately
 06 2,000 years after the development of domesticated plants and animals, and just
 07 before the 8.2 ky climatic shift. To what extent is this transition related to envi-
 08 ronmental, social and economic shifts?

09 Given space limitations I want to focus on the emergence of large LPPNB vil-
 10 lages some 1,200–1,500 years after domestication occurred, and make two argu-
 11 ments: first, their appearance was at least partially linked to population aggregation
 12 rather than increased growth rates, and second, that unlike the European context,
 13 the southern Levantine transition was less marked or abrupt. Clearly any trajectory
 14 of regional Neolithic demographics potentially conflates two interrelated processes:
 15 (1) gradual and steady regional population growth through the Neolithic period(s),
 16 and (2) population aggregation in large and important settlements for ritual, political
 17 and economic reasons (Rollefson 1987). Disentangling these is, needless to say,
 18 challenging and complex, and of considerable importance to understand the social
 19 and demographic contexts of Neolithic lifeways. For methodological reasons, we
 20 need to understand this relationship to accurately estimate population levels. Since
 21 population pressure and growth are potential mechanisms of long-term change, this
 22 awareness is critical for us to understand the social and evolutionary processes that
 23 brought people together in the LPPNB.

24 While it is tempting to view the growth of LPPNB villages as reflecting some
 25 direct by-product of the NDT, I think there are strong reasons to suspect that the phe-
 26 nomenon is linked to population aggregation, economic shifts and the development
 27 of new systems of property and ownership. Over the last 15 years archaeologists
 28 working in the southern Levant have demonstrated that people living in the LPPNB
 29 built a series of large settlements, with densely packed one and two-story residential
 30 housing, and occupied by hundreds if not thousands of people (Fig. 4) (Banning
 31 1998; Bar-Yosef and Meadow 1995; Gebel 2004; Rollefson 1989; 1998; Simmons
 32 2000). Despite the broad horizontal extent of these villages, as well as the densely
 33 packed architecture, archaeologists have noted a puzzling pattern: the apparent un-
 34 der representation of human burials in LPPNB villages (Bienert et al. 2004). In one
 35 of most direct explorations of this topic Bienert et al. (2004) provide a range of
 36 possible explanations for this pattern. Reflecting further on the question of where
 37 are the dead, it strikes me that there is no corresponding increase in the number
 38 of burials and site size in the LPPNB, and that the number of burials per standard
 39 area in the MPPNB and LPPNB are relatively similar. If correct, this supports the
 40 argument that annual population growth rates in MPPNB and LPPNB communities
 41 were relatively similar. From this perspective, the increase density of architecture
 42 and large horizontal extent of LPPNB settlements were related to shifts in how labor
 43 was organized, how food and other resources were stored and how buildings were
 44 constructed. I will return to this point in the second half of this chapter.
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33 **Fig. 4** Changing architectural systems in the Southern Levantine Pre-Pottery Neolithic A and Pre-Pottery Neolithic B periods (illustrations by I. Kuijt)

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37 **The Abandonment of LPPNB Villages**

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39 With the end of the LPPNB we find evidence for the break-up of large villages
40 into much smaller villages and hamlets of the Pottery Neolithic, presumably with
41 changes in social, economic and political organization. While the settlement data
42 presented here appear to support the continued existence of large settlements into
43 the early PN, these are very different from the settlements of the LPPNB. The large
44 settlements from the LPPNB, PPNC and early Pottery Neolithic periods (such as
45 at sites of Basta, 'Ain Ghazal, Sha'ar Hagolan 1 and Atlit Yam), illustrate a very

01 different material and architectural form. In the early Pottery Neolithic period (local
 02 expressions of which are termed Yarmoukian and Jericho IX), some settlements
 03 (such as Sha'ar Hagolan 1 and 'Ain Ghazal) were still quite large.³ Despite changes
 04 in lithic technology, economy, mortuary practices, and the development of ceramic
 05 technology, it appears that some groups still lived in large villages in the early PN.
 06 These villages, however, were significantly different. Early PN villages had a much
 07 lower density of residential architecture; only single-story buildings widely spaced
 08 throughout the site, and resulted in fewer cultural deposits. As argued by Banning
 09 et al. (1994), and Banning (2004) the transition to the later phases of the Pottery
 10 Neolithic represents a shift in settlement systems, one where we see the establish-
 11 ment of new smaller settlements. Research in Syria by Akkermans et al. (2006)
 12 argues that this pattern reflects small groups frequently building hamlets in the same
 13 general area. They (2006:154) comment: "Whereas people at the start of the Pottery
 14 Neolithic primarily continued the life of their ancestors in the same place, those at
 15 the end of the epoch began to exploit an even more extensive area in a flexible and
 16 varied way." The combination of these overlapping of spatially discrete occupations
 17 created the appearance of a much larger settlement. By the end of the general PN
 18 period, and more specifically, the PN B period (Readers are directed to Gopher and
 19 Gophna 1993 for further discussion of the PN) the average size of settlements was
 20 often less than 1 or 2 ha. This broader transition, then, can be characterized as the
 21 move from a high-density residential housing to dispersed hamlets reflecting smaller
 22 economic and social units.

23 If the appearance of such large settlements a 1,000–1,500 years after the appear-
 24 ance of the first domesticated plants and animals in the Near East is not related to
 25 regional population growth, then how do we explain it? Assuming that the extensive
 26 horizontal extent of LPPNB architecture reflects population increase rather than
 27 new systems of building, we can identify several explanations for the emergence
 28 of LPPNB villages and population growth:

- 29 1. Increased interpersonal conflict. The developments of new forms of food pro-
 30 duction resulted in heightened levels of interpersonal conflict and competition
 31 for resources. From this perspective regional population growth would have been
 32 relatively stable, but competition over diminishing resources and water may have
 33 created the context for people to aggregate into limited number of larger com-
 34 peting villages.
- 35 2. Economic intensification and labor. Economic intensification and the emergence
 36 of the relatively new agro-pastoral economy would have changed labor needs,
 37 and potentially contributed to the context for population aggregation. The poten-
 38 tial needs for seasonal labor, and perhaps the improved access and quantities of
 39 dairy products, would have encouraged people to live in larger communities and
 40 improved the nutritional context of life.
- 41 3. More elaborate ritual and social practices. In light of increasingly fissive social
 42 forces, such as scalar stress, people may have developed new social and ritual
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44
 45 ³ For the purposes of this chapter I am using the term 'large' to identify any site that is larger than
 6 ha in surface area.

01 practices to hold communities together. While producing a similar archaeologi-
02 cal signature to the first point, this clustering of people would have been linked
03 to control and access to ritual, rather than protection.

04 Clearly, much more work is necessary to understand the social, economic and
05 demographic contexts of LPPNB village abandonment. In the remaining part of
06 this chapter I want to shift focus to the possible role of economic intensification,
07 and more specifically, the possible connection between changes in food storage, the
08 increased subsistence buffer resulting from such storage and how this might have
09 been connected to demographic change.
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11 12 **Food Storage and the NDT** 13

14 Despite its importance in the forager–farmer transition, remarkably little research
15 has explored the role of developing food storage and changes in food production
16 as a foundation for the NDT. The structure of subsistence resources influences
17 different cultural trajectories, and storage practices alter the balance between hu-
18 man reproductive success and the density and richness of resources. If the NDT
19 was fundamentally based on increased birth rates due to improved quantity and
20 quality of domesticated plants, then this should be reflected in the archaeological
21 evidence for storage practices. Is there archaeological evidence for an increase in
22 the number, quantity or location of Neolithic storage systems with the appearance
23 of domesticates? The quick answer is yes, but the real answer is more complicated.
24 To understand some of these complexities it is necessary to look at the evidence for
25 food storage.

26 Now that we have explored settlement change during the southern Levantine
27 NDT, let us return to the earlier social and economic foundations from which the
28 NDT developed. In stark contrast to the European Mesolithic, the Epipaleolithic
29 and early Neolithic of the Near East was characterized by a significant seasonal
30 residential sedentism, and the intensive and extensive harvesting of wild plants (Bar-
31 Yosef 1998). There is growing direct and indirect evidence, moreover, for some
32 level of food storage in pre-domesticated contexts *before* the NDT. This suggests,
33 in short, that in the case of the southern Levantine Neolithic, the subsistence and
34 nutritional foundation for the NDT occurred earlier than previously anticipated and
35 was initially based on wild resources. This highlights that in the case of the Levant,
36 it is the move to sedentism, food storage and food production that was important,
37 and not plant domestication.
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39 40 ***Early and Late Natufian Period Food Storage*** 41

42 As with earlier peoples, the Natufians were focused on intensive and extensive har-
43 vesting of wild cereals (Bar-Yosef 1998). Natufian people utilized a remarkably
44 wide range of wild plants and animals and probably had a detailed knowledge of
45 the seasonality and availability of these resources. Certainly the increased degree

01 of sedentism in the Natufian period suggests that people were able to reduce sea-
02 sonal food risks to the point where they could live in the same areas for one or
03 more seasons of the year. There is, however, surprisingly little direct evidence for
04 food storage. As noted by Bar-Yosef (1998), Ain Mallaha is the only site with any
05 evidence for storage features, these being pit features partially coated with plaster.
06 At the same time, there is considerable indirect evidence for food processing and
07 storage, including the presence of sickles, food processing tools, such as mortars,
08 pestles and bowls, all of which are interpreted as evidence for gathering and process-
09 ing of pulses, cereals, almonds and other plants. One, but by no means the only, way
10 of achieving this relative increase was through the development of new harvesting,
11 processing and storage systems for food. Collectively, this indicates that Natufian
12 people must have engaged in some form of lower level food storage, perhaps ori-
13 ented toward smaller groups.

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16 *Pre-Pottery Neolithic A Period Food Storage*

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18 As with the Natufians, people in the PPNA developed a food surplus of wild plants
19 based on the intensive collection and possibly cultivation of plants. Archaeological
20 excavations have revealed that by (11,500 cal) BP in the southern Levant PPNA
21 people employed at least two types of storage systems: small bins and larger stor-
22 age silos.

23

24 Excavations at Netiv Hagdud and Jericho provide evidence for the use of small
25 clay bins, possibly, but not unequivocally, linked to food storage. Two of these were
26 identified at Netiv Hagdud (Bar-Yosef and Gopher 1997) and appear as small areas
27 enclosed by mud walls preserved up to a height of ca. 10 cm. Due to limited preser-
28 vation conditions it is not clear how high these wall stood, nor for that matter if they
29 were located inside or outside of a structure. The excavators believe that these were
30 used for some form of food storage or preparation features and that they were lo-
31 cated inside of the structure. Similarly, Kenyon (1981) reports numerous small stone
32 bin features at Jericho, such as the bins of phase DI.xxix (Kenyon 1981: Plate 37a).

33 The evidence for storage silos comes from excavations at Dhra', Netiv Hagdud
34 and Jericho. Excavations at Dhra' have uncovered the remains of large storage silos
35 constructed and used during the PPNA (Finlayson et al. 2003; Kuijt and Finlayson
36 2001). These storage silos were built on upright stones used to suspend wooden
37 beams. The upright stones, many of which were recycled grinding stones, were
38 notched on one end to allow for the suspension of wooden beams in creating a small
39 (45–35 cm) sub-floor to allow for drainage and ventilation. Excavations at Netiv
40 Hagdud (Bar-Yosef and Gopher 1997) produced a similar feature to that seen at
41 Dhra', although this one was not as well preserved. This building, known as Locus
42 26, was a 3 × 3 meter structure defined by a mud wall. With the exception of the
43 absence of upright stones, which may have been robbed for later buildings for some
44 residential construction, the building is quite similar. Bar-Yosef and Gopher (1997)
45 argue, in fact, that that structure was probably used for food storage, and as with the
examples from Jericho, may have served as a dedicated storage building.

01 There are several important points to note here. First, the presence of these stor-
02 age silos represents a form and scale of food storage not found in the Natufian
03 period (Bar-Yosef 1998). If representative of regional practices in the PPNA, then
04 this suggests that people not only had a food surplus but that this surplus was also of
05 a significant scale. Second, it is important to note that these silos were developed for
06 the storage of wild plant resources. Finally, these data provide evidence for the nu-
07 tritional and caloric foundation, largely focused on wild cereals, nearly 1,000 years
08 *before* the NDT. This economic foundation facilitated higher sedentism, established
09 one of the necessary preconditions for increased birth rate seen in the MPPNB and
10 collectively brought about changes in ideas and values attached to food storage.

11 12 13 ***Middle Pre-Pottery Neolithic B Period Food Storage***

14
15 It is at around 10,500 years ago calibrated, during the MPPNB period, that we find
16 our first evidence for large-scale storage practices occurring inside and outside of
17 buildings (Tables 1 and 2). First, indisputable evidence for MPPNB food storage
18 comes from the remains of storage bins located inside and outside of structures. In
19 the excavations of Yiftahel, Garfinkel (1987) recovered the well-preserved archae-
20 ological remains of a mud storage feature placed in the corner of a room. While
21 only partially preserved, this feature was lined with plaster/clay with an opening
22 that allowed for people to reach into the storage bin. Clearly these installations
23 were dedicated and purposefully designed features for food storage. Similarly, the
24 excavations of Jericho revealed clear evidence for the construction of clay bins
25 of the same design and relative size as the one from Yiftahel. This illustrates a
26 pattern of intentional preservation and storage of food inside buildings for later
27 consumption by multiple people. It is possible, therefore, that access to some of
28 these stored foods may have been restricted and controlled by house or community
29 leaders.

30 Second, there is evidence for storage in the location of post-holes inside of struc-
31 tures. Excavation results from 'Ain Ghazal (Rollefson 1989; Rollefson et al. 1992)
32 provide important insights into the organization of space inside and outside of build-
33 ings. Their excavations revealed portions of MPPNB buildings with large wooden
34 posts set in upright positions as roof supports. In addition, smaller post-holes define
35 a separate area. Connected together these posthole partitions outline areas in the
36 corner of a room, in one case with an associated flagstone floor, and in other cases,
37 areas at the backs of rooms. Third, we have the remains of small alcoves inside
38 of MPPNB structures created by stone walls. The internal walls of these structures
39 both created 1 × 2 meter areas and also served as structural supports for the roof.
40 These enclosed areas would have been too small for sleeping. Thus, they proba-
41 bly served as the main internal storage areas for residence. These developments
42 occurred long after the appearance of domesticated plants and animals. It is clear
43 that MPPNB storage features were different from those of the PPNA, but this evo-
44 lutionary pattern is very different from that of the European Mesolithic/Neolithic
45 transition.

Table 1 General aspects of Levantine Natufian and Pre-Pottery Neolithic storage practices.

	Extra-mural	Inter-mural	Architecture	Interpretation	Sites
Early Natufian c. 14,500–12,800 BP	<ul style="list-style-type: none"> • No evidence 	<ul style="list-style-type: none"> • Possible rare storage installations 	<ul style="list-style-type: none"> • Single-story oval architecture • Free-standing semi-subterranean buildings 	<ul style="list-style-type: none"> • Low residential mobility and some storage • Unclear access 	<ul style="list-style-type: none"> • 'Ain Mallaha, Hayonim cave, Kebarah, Wadi Hameh 27
Late Natufian c. 12,800–11,700 BP	<ul style="list-style-type: none"> • No evidence 	<ul style="list-style-type: none"> • No evidence 	<ul style="list-style-type: none"> • Single-story oval architecture • Free-standing semi-subterranean buildings 	<ul style="list-style-type: none"> • Highly mobile groups with limited storage • Unclear access 	<ul style="list-style-type: none"> • 'Iraq ed-Dubb, Fazael IV, Givat Hayil, Baaz Rockshelter
Pre-Pottery Neolithic A period (PPNA) ca. 11,700–10,500 BP	<ul style="list-style-type: none"> • Extra-mural storage silos 	<ul style="list-style-type: none"> • Small storage installations in rooms? 	<ul style="list-style-type: none"> • Single-story oval architecture • Free-standing Semi-subterranean buildings 	<ul style="list-style-type: none"> • Low residential mobility and significant storage • Separation of residential and storage areas 	<ul style="list-style-type: none"> • Netiv Hagdud, Jericho, Dhra 'Gilgal I, Zahrat adh-Dhra' 2
Middle Pre-Pottery Neolithic B period (MPPNB) ca. 10,500–9,250 BP	<ul style="list-style-type: none"> • Clay storage installations in open areas 	<ul style="list-style-type: none"> • Clay storage installations in corner/sides of room • Small compartments 	<ul style="list-style-type: none"> • Single-story rectangular architecture • Free-standing buildings • Sub-basement? 	<ul style="list-style-type: none"> • Relatively open access • Low residential mobility and significant storage • Integration of storage facilities and residential areas • Restricted access 	<ul style="list-style-type: none"> • 'Ain Ghazal, Yiftahel, Jericho, Kfar Hahorish

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Table 1 (continued)

	Extra-mural	Inter-mural	Architecture	Interpretation	Sites
Late Pre-Pottery Neolithic B period (LPPNB) ca. 9,250–8,700 BP.	<ul style="list-style-type: none"> • Unclear (Limited excavations) 	<ul style="list-style-type: none"> • Transition to dedicated storage rooms 	<ul style="list-style-type: none"> • Two-story rectangular architecture • Abutting buildings • Access by ladder/stairs from above? 	<ul style="list-style-type: none"> • Low residential mobility and significant storage • Integration of residential and storage areas • Restricted access • Low residential mobility and significant storage • Separation of residential and storage areas? • Unclear access 	Basta, 'Ain Ghazal, Es-Sifiya, 'Ain Jammam, Ghwair, Ba'ja
Pre-Pottery Neolithic C period (PPNC) ca. 8,700–7,800 bp	<ul style="list-style-type: none"> • No evidence 	<ul style="list-style-type: none"> • Dedicated storage buildings? 	<ul style="list-style-type: none"> • Abandonment of two-story architecture • Single-story buildings 	<ul style="list-style-type: none"> • Low residential mobility and significant storage • Separation of residential and storage areas? • Unclear access 	'Ain Ghazal, Khirbet Sheikh Ali, Atlit Yam

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Table 2 Food surplus and practical storage: archaeological manifestations in the Levantine Pre-Pottery Neolithic

	Plant economy	Animal economy	Organization of practical storage (Dedication/Integration)	Scale of storage (Residential to Communal)	Access to stored materials (Restricted to open)
Early Natufian c. 14,500–12,800 BP	Intensive collection and variable cultivation of local wild plant resources	Intensive hunting of wild animal resources: no evidence for subsistence husbandry	• Storage inside and outside of residential unit in public context	• Very small volume	• Relatively unrestricted spatial access
Late Natufian c. 12,800–11,700 BP	Intensive collection and variable cultivation of local wild plant resources	Intensive hunting of wild animal resources: no evidence for subsistence husbandry	• Storage inside and outside of residential unit in public context	• Very small volume	• Relatively unrestricted spatial access
Pre-Pottery Neolithic A period (PPNA) ca. 11,700–10,500 BP	Intensive collection and variable cultivation of local wild plant resources: possible early domestication of some plants	Intensive hunting of wild animal resources: no evidence for subsistence husbandry	• Dedicated/storage outside of residential unit in public context	• Small volume	• Relatively unrestricted spatial access
Middle Pre-Pottery Neolithic B period (MPPNB) ca. 10,500–9,250 BP	Collecting and cultivation of wild plant resources: variable use of a wide range of domesticates depending upon location	Hunting of wild animal resources: domestication of caprines (goat-sheep) for meat and secondary products	• Dedicated/storage inside of residence	• Medium volume	• Storage installations in corner/sides of room • Clearly identified storage locations

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Table 2 (continued)

	Plant economy	Animal economy	Organization of practical storage (Dedication/Integration)	Scale of practical storage (Residential to Communal)	Access to stored materials (Restricted to open)
Late Pre-Pottery Neolithic B period (LPPNB) ca. 9,250–8,700 BP.	Primarily focused on a restricted range of domesticates depending upon location	Hunting of wild animal resources: increased reliance upon narrow spectrum (caprines, pig, cattle)	<ul style="list-style-type: none"> • Dedicated/separate rooms for storage 	<ul style="list-style-type: none"> • High volume 	<ul style="list-style-type: none"> • Spatially restricted access from second floor to first floor • Dedicated storage rooms in lower floor of building
Pre-Pottery Neolithic C period (PPNC) ca. 8,700–7,800 bp	Primarily focused on a restricted range of domesticates depending upon location	Hunting of wild animal resources: increased reliance upon narrow spectrum (caprines, pig, cattle)	<ul style="list-style-type: none"> • Dedicated/separate rooms for storage 	<ul style="list-style-type: none"> • Unclear 	<ul style="list-style-type: none"> • Single-story buildings • Dedicated storage rooms in lower floor of building

01 ***Late Pre-Pottery Neolithic B Period Food Storage***

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03 As in the MPPNB, LPPNB storage space was located in internal areas of buildings
04 (assuming we are not missing important remains). In the LPPNB people developed
05 new, larger enclosed storage areas, where access could be controlled. Archaeologi-
06 cal evidence for storage systems is seen in dedicated storage rooms inside of build-
07 ings, in some cases with specially designed doorways (see Fig. 4c).

08

09 It is in the LPPNB we find our first evidence for two story-buildings, probably
10 with people using space in ground level and upper floors differently. Architectural
11 practices in the LPPNB shifted to the construction of rooms that shared common
12 walls. In some cases rooms were added to buildings and in other cases they were
13 pre-planned and purposefully designed. At Es-Sifyia people constructed multi-story
14 buildings along a relatively steep slope area, with remarkably dense architecture
15 (Mahasneh 1997; Mahasneh and Bienert 2000). Many of these buildings had small
16 (ca. 1.5 × 1.5 meter) rooms, with no windows to exterior areas, and half-door
17 entrances connecting to what was probably a central room. These rooms, as well
18 as at Basta and Es-Sifyia, were accessed from central or adjacent rooms through
19 small half-door entrances that are about 1 meter high (Kuijt 2001; Nissen et al.
1987).

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21 The half-door system, with stone below and some form of wooden door for the
22 upper half, were useful in creating a barrier against rodents and insects (Fig. 4c).
23 This would have created a storage room where sacks or baskets of foods could
24 have been securely stored. Regardless of what was being stored in these areas, it
25 is clear that in the LPPNB people started to actively define space in new ways that
26 limited access to stored resources. Excavations have also provided new informa-
27 tion on the spatial connection between LPPNB food storage and food preparation.
28 This includes recovery of domesticated plants from storage areas at 'Ain Ghazal
29 (Rollefson 1997) and Es-Sifyia. In many of the rooms large grinding stones were
30 left in place, illustrating the spatial connection between food processing and storage
31 (Wright 2000). The food preparation rooms were located relatively evenly across
32 the excavation area.

32

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34 ***Pre-Pottery Neolithic C Period Food Storage***

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36 Archaeologists have a poor understanding of food storage in the PPNC. (Readers
37 are directed to Rollefson (2001), and Rollefson and Köhler-Rollefson (1989) for the
38 most detailed examination of the PPNC.) As of 2007, no archaeologists have exca-
39 vated a large horizontal area of a PPNC settlement. As such, researchers know re-
40 markably little about how settlements might have been organized, how large PPNC
41 settlements might have been, the extent to which people living in PPNC villages
42 were mobile or if they were economically focused on the same subsistence resources
43 as in the LPPNB.

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Table 3 Comparison of estimated storage area and residential areas by period

(a) Mean settlement size (ha) (100 × 100 m) (1000 m ²)	(b) Number of compartments (100 m ²)	(c) Number of compartments/site	(d) Ratio of potential storage space to internal area of buildings	(e) Average storage space	(f) Average storage space/Potential storage space (m ²) (= c and e)	(g) Total storage space at 20% occupancy of site
Early Natufian c. 14,500–12,800 BP	0.2	20	Similar to PPNA Ratio of .11	ca. 2.25 m ²	4.95	0.99
Late Natufian c. 12,800–11,700 BP	0.2	20	Less than E. Natufian	ca. 2.25 m ²	4.95	0.99
Pre-Pottery Neolithic A period c. 11,500–10,500 BP	1	240	= 1:7.7–1:10.2 Ratio of .11	ca. 6.25 m ²	165 m ²	33 m ²
Middle Pre-Pottery Neolithic B period c. 10,500–9,250 BP	2.5	1575	= 1:2.2–1:4.4 Ratio of .33	ca. 2.25 m ²	1,169 m ²	233.8 m ²
Late Pre-Pottery Neolithic B period c. 9,250–8,700 BP	10	14,500	= 1: 1.3–1: 2.6 Ratio of .5	ca. 2.25 m ²	16,312 m ²	3,262.4 m ²

01 *Pottery Neolithic Period Food Storage*

02

03 The earliest phases of the Pottery Neolithic illustrate a dramatic shift in how peo-
04 ple stored foods, and most probably, the scale and intensity of food storage. In the
05 early PN period settlements such as Sha'ar Hagolan 1 and 'Ain Ghazal, it does
06 not appear that dedicated storage rooms were constructed as integrated parts of
07 residential structures. Instead we see a return to dedicated external storage contexts.
08 Excavations at Sha'ar Hagolan 1 (Garfinkel and Miller 2002), for example, illustrate
09 the PN use of a wide range of features inside and outside of structures that could
10 have been used for small-scale food storage and preparation, including cobblestone
11 installations, raised stone platforms and most importantly the frequent use of pit
12 features outside of structures. While the specific locations of food storage remain
13 unclear in these households, it appears that in comparison to the densely packed
14 LPPNB villages, people in the more dispersed PN villages had less physical space
15 focused on storage. Moreover, food storage was more frequent in areas outside of
16 the main residential building, but inside the compound area defined by stone and
17 mud walls.

18 In sum, there appears to be a correlation between increased scale of MPPNB and
19 LPPNB settlements size and storage systems, and this pattern changes drastically
20 in the PN, regardless of the size of settlement. There is solid evidence for the ap-
21 pearance of new storage systems in the MPPNB, and storage of significant foods.
22 While suggestive, the archaeological data from the LPPNB are not unequivocal due
23 to methodological questions. The existence of large dedicated rooms is suggestive
24 of an increase in the scale and control of access to storage within buildings. It is
25 not clear, however, how much of this is linked to food storage, fuel or other eco-
26 nomic goods.

27

28

29 **Discussion**

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31 It is widely held that sedentism and improved control of plants resources were major
32 factors in the NDT (e.g., Bocquet-Appel 2002). I agree with this argument. I suspect,
33 however, that further research and this conference will move us beyond this general-
34 ization and demonstrate that the timing and pathways of the NDT varied in different
35 case studies. This comparative approach will help us explore new questions.

36 One outgrowth of this study centers on the importance of food storage. Build-
37 ing on the work of Testart (1982), I argue that the initial stages of the southern
38 Levant NDT were linked to food storage. Pre-domesticated food storage served as
39 an economic and nutritional foundation for the NDT several thousand years before
40 domestication. As noted earlier, people in the PPNA stored pre-domesticated plant
41 surplus, and people in the MPPNB developed a series of new complex systems for
42 storing domesticated plants. The existence of morphologically domesticated plants,
43 as well as specific stone tools for harvesting and processing and now analysis of
44 MPPNB features, highlights the importance of food storage. Looking at similar pat-
45 terns at Jericho, 'Ain Ghazal and Yiftahel, helps us to recognize the development

01 of extensive and intensive food storage systems in these villages. Although neither
02 exhaustive nor complete, this study clearly illustrates a significant ratcheting up of
03 storage practices, and probably a new system and ideas about ownership, with the
04 appearance of domesticated plants and the start of the NDT. In light of the likely nu-
05 tritional improvements, and predictability that effective storage systems would have
06 brought to PPNA communities, it is not clear why we do not see a more significant
07 improvement in health or population growth rates before the MPPNB.

08 A second outgrowth is an understanding that the southern Levantine NDT was
09 significantly different from that seen in Europe. Some of this is probably linked to
10 the Near East being a primary center of domestication. This examination of southern
11 Levantine settlement data reveals a pattern of gradual growth followed by continued,
12 if not heightened, population aggregation in the LPPNB at least 1,200 years after
13 domestication. Some of this is likely to be related to methodological assumptions
14 (overestimating the number of people per structures is probably a major factor in
15 this) and some of it may be related to shifts in building construction and economic
16 systems. Given that the increase in the horizontal extent of LPPNB settlements oc-
17 curred some 1,200 years after the appearance of domesticated plants and animals, it
18 is not at all clear that the emergence of these villages was linked to increased birth
19 rate and the NDT phase one. An alternative perspective, and one that is in need of
20 future investigation, is that the emergence of large LPPNB villages was related to
21 the NDT in a different way: the incorporation and impact of secondary products,
22 such as milk, from domesticated animals.

23 Combined with our understanding of population growth and food storage in the
24 southern Levant, we may be looking at a Neolithic Demographic pattern that was
25 linked to three interrelated, yet very different, processes:

- 26 1. The development of Natufian and PPNA intensive and extensive collecting,
27 harvesting and storage of wild plants. This would have served as a foundation
28 for later domestication of plants as well as the biological and technological
29 foundations for the first stage of the NDT.
- 30 2. The domestication of plants and animals in the MPPNB. With increased seden-
31 tism, new forms of food storage, and greater control over plant resources,
32 population levels would have rapidly increased. Developing new food storage
33 systems, and with a greater surplus of stored plants, birth rates would have in-
34 creased and resulted in the development of relatively large MPPNB villages.
- 35 3. Expanded and new use of animal resources. By increasing the quality and quan-
36 tity of dairy products, the domestication of animals would have provided new
37 opportunities for population growth in the LPPNB. While in need of further
38 research, I think it is possible that these new dietary conditions countered in-
39 creased mortality rates hypothesized by Bocquet-Appel (2002). Given the local
40 sequence for the southern Levant, therefore, such a new dietary reality may have
41 created a second, and in some ways delayed, demographic signature.

42
43 If one believes that that the underlying proximal factors in increased Neolithic
44 birth rates were linked to increased quality and access to plant foods throughout the
45 year, and reduced stress for females, then it is crucial for researchers to understand

01 the role of food storage with the NDT. As a minimum the development of food
 02 storage technology reflects a critical transition in ideas and values about storage,
 03 and just as importantly, heralds a new way of life (Ingold 1983; Testart 1982). As
 04 with most research, this exploration of human demography, settlement systems and
 05 food storage, has probably raised more questions than it has answered. In doing
 06 this, however, I think an improved understanding of southern Levantine Neolithic
 07 food storage and demography directs us to new questions, and helps us refine our
 08 understanding of the NDT.

09
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